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Annual report of the New Jersey State Agricultural Experiment ...

New Jersey Agricultural Experiment Stations

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New Jersey Agricultural
Experiment Station

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THIRTY-SECOND ANNUAL REPORT

OF THE

NEW JERSEY STATE

Agricultural Experiment Station

AND THE

TWENTY-FOURTH ANNUAL REPORT

OF THE

New Jersey Agricultural College Experiment Station

FOR THE YEAR ENDING OCTOBER 31ST

1911

TRENTON, N. J.
STATE GAZETTE PUBLISHING CO., PRINTERS.
1912.

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NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS

NEW BRUNSWICK, N. J.

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RICHARD S. TERHUNE, Field Assistant.
HARRY R. LEWIS, B.Sc., Poultry Husbandman.
MORRIS SIEGEL, Poultry Foreman.
MORRIS A. HALPRIN, Assistant.

---

2. AGRICULTURAL COLLEGE STATION. ESTABLISHED 1888.

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JOHN V. CROOT, Field Assistant.

LETTERS OF TRANSMITTAL

To His Excellency, Woodrow Wilson, Governor of the State of New Jersey:

SIR—I have the honor to submit herewith the Thirty-second Annual Report of the New Jersey State Agricultural Experiment Station, as required by the law establishing the Station, which was approved March 10th, 1880, and which is chapter 106 of the laws of that year.

DAVID D. DENISE,
President.

NEW BRUNSWICK, N. J., November 30th, 1911.

To His Excellency, Woodrow Wilson, Governor of the State of New Jersey:

SIR—In compliance with an act of Congress, approved March 2d, 1887, and with an act of the Legislature of this State approved March 5th, 1888, I beg leave to submit, on behalf of the Trustees of Rutgers College in New Jersey, maintaining Rutgers Scientific School, the New Jersey State College, for the benefit of Agriculture and Mechanic Arts, the Twenty-fourth Annual Report of the operations of that department of the College which has been organized in accordance with said act of Congress, and is known as "The State Agricultural College Experiment Station."

W. H. S. DEMAREST,
President.

NEW BRUNSWICK, N. J., November 30th, 1911.

TREASURER'S REPORT.

Irving S. Upson, in account with the New Jersey State Agricultural Experiment Station, November 1st, 1910, to October 31st, 1911.

Appropriation for Salaries and Expenses.

RECEIPTS.

From State Treasurer	$22,500 00

PAYMENTS.

Salaries and Wages	$16,283 16
Books and Magazines	123 75
Chemical Supplies	425 19
Coal	190 95
Electric Current	65 80
Express and Freight	244 66
Farm Machinery and Tools	348 99
Feed	19 70
Fertilizers	411 44
Gas	182 93
Insurance	44 35
Office Furniture	19 05
Office Supplies	214 18
Photographic Supplies	162 32
Postage	161 15
Printing and Stationery	653 59
Repairs	401 74
Scientific Apparatus	191 22
Team Hire	162 00
Telephone	112 75
Telegraph	7 23
Traveling Expenses—Managers	114 83
Traveling Expenses—Officers	952 69
Traveling Expenses—Sampling Fertilizers	343 17
Trees, Seeds and Vines	304 04
Water	135 73
Sundries	223 39
Total	$22,500 00

Appropriation for Carrying Out the Provisions of "An Act Concerning the Regulation of the Sale of Concentrated Commercial Feeding Stuffs."

RECEIPTS.

From State Treasurer	$3,000 00

PAYMENTS.

Salaries and Wages	$2,796 65
Express and Freight	15 85
Postage	4 18
Traveling Expenses—Sampling Feeds	183 32
Total	$3,000 00

Appropriation for Printing Bulletins.

RECEIPTS.

From State Treasurer	$2,000 00

PAYMENTS.

For Printing Bulletins	$2,000 00

Appropriation for the Purpose of Carrying Into Effect "An Act to Provide for Locating and Abolishing Mosquito-Breeding Salt-Marsh Areas Within the State, for Assistance in Dealing With Certain Inland Breeding Places, and Appropriating Money to Carry Its Provisions Into Effect."

RECEIPTS.

From State Treasurer	$12.000 00

PAYMENTS.

Salaries	$3,058 31
Advertising	52 16
Blasting Material	95 21
Chemical Supplies	76 20
Express and Freight	12 08
Field Work	7,585 97
Photographic Supplies	65 74
Postage	23 37
Printing and Stationery	21 65
Scientific Apparatus	20 08
Telegraph	75
Traveling Expenses—Officers	934 35
Sundries	54 13
Total	$12.000 00

Appropriation for the Purpose of Meeting the Expenses of the Experiment Orchards at Vineland and High Bridge.

RECEIPTS.

From State Treasurer	$1,258 64

PAYMENTS.

Building Packing Houses	$305 00
Farm Machinery and Tools	429 63
Office Supplies	1 80
Photographic Supplies	6 50
Printing and Stationery	55 15
Trees, Seeds and Vines	26 26
Sundries	9 69
Lease of Land and Care of Orchards	424 61
Total	$1,258 64

Appropriation for Buildings Appropriate to the Housing of the Department of Poultry Husbandry.

RECEIPTS.

From State Treasurer	$1,050 00

PAYMENTS.

For Poultry Buildings	$1,050 00

Appropriation for the Purchase of Equipment, Stock and Supplies Necessary for the Establishment of the Department of Poultry Husbandry.

RECEIPTS.

From State Treasurer	$945 00

PAYMENTS.

For Poultry Equipment, Stock and Supplies	$945 00

Appropriation for the Maintenance and Operation of the Department of Poultry Husbandry.

RECEIPTS.

From State Treasurer	$1,000 00

PAYMENTS.

Carpenter Work	$86 00
Grading and Excavating	146 52
Gravel and Cinders	119 75
Express and Freight	9 64
Office Supplies	20 35
Photographic Supplies	16 20
Postage	14 00
Printing and Stationery	10 05
Poultry Supplies, Tools, &c	229 95
Poultry Stock	56 70
Poultry Feed	39 37
Telephone	70
Traveling Expenses—Officers	82 07
Wages	152 00
Sundries	16 70
Total	$1,000 00

The Auditing Committee of the Experiment Station has examined the accounts of the Treasurer of said Station, and has found them correct.

(Signed) D. D. DENISE,
GEORGE E. DE CAMP,
Auditing Committee.

FINANCIAL STATEMENT.

The Trustees of Rutgers College
for
The New Jersey State Agricultural College Experiment Station
in account with
The United States Appropriation, 1910-1911.

RECEIPTS.

From the Treasurer of the United States—	
Hatch Act	$15,000 00
Adams Act	14,558 78
Balance from Appropriation for 1909-1910, Adams Act	441 22
	$30,000 00

DISBURSEMENTS.

	Hatch Act.	*Adams Act.*	
Salaries	$8,691 65	$9,118 32	$17,809 97
Labor	697 88	1,321 98	2,019 86
Publications	1,106 08	......	1,106 08
Postage and Stationery	438 60	73 64	512 24
Freight and Express	44 33	31 56	75 89
Heat, Light, Water and Power	414 24	145 32	559 56
Chemicals and Laboratory Supplies	144 14	696 77	840 91
Seeds, Plants and Sundry Supplies	233 80	644 95	878 75
Fertilizers	......	254 00	254 00
Feeding Stuffs	......	240 00	240 00
Library	757 00	275 55	1,032 55
Tools, Machinery and Appliances	......	228 08	228 08
Furniture and Fixtures	702 51	419 00	1,121 51
Scientific Apparatus and Specimens	543 55	1,143 52	1,687 07
Live Stock	......	......	......
Traveling Expenses	473 75	20 09	493 84
Contingent Expenses	63 67	......	63 67
Buildings and Land	688 80	387 22	1,076 02
Balance	......	......	......
	$15,000 00	$15,000 00	$30,000 00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the New Jersey State Agricultural College Experiment Station for the fiscal year ended June 30th, 1911; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was $...... on the Hatch Fund and $441.22 on the Adams Fund; that the receipts for the year from the Treasurer of the United States were $15,000.00 under the act of Congress of March 2d, 1887, and $14,558.78 under the act of Congress of March 16th, 1906, and the corresponding disbursements $15,000.00 and $15,000; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving balances of $...... and $......

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2d, 1887, and March 16th, 1906, and in accordance with the terms of said acts, respectively.

(Signed) W. H. S. DEMAREST,
J. G. LIPMAN,
Auditors.

REPORT OF THE DIRECTOR.

REPORT OF THE DIRECTOR.

Provision was made, within the past year, for enlarging the usefulness of the Experiment Station. The legislation of the past winter has made possible the establishment of a poultry department, and of the building of greenhouses for floricultural experiments. Thanks to this action of the Legislature the Experiment Station will be in a position to contribute toward the prosperity of the poultry industry in New Jersey. It is evident even now that the provision for poultry experiments at the State Experiment Station is appreciated by the poultrymen in the State, and it is hoped that the experimental and extension work (which is to be carried on at the station) will help to place the poultry industry on a solid foundation.

The investigations on the growing of roses and carnations, which the Experiment Station is now carrying on, and which will be extended, thanks to the new greenhouses and equipment provided for this purpose, are certain to fill a long felt want. It has already been demonstrated, by the experiments in progress, that satisfactory and profitable yields of roses may be secured by the use of chemical fertilizers. The proper use of such fertilizers will eliminate much uncertainty from commercial rose production, and will assure the rose grower better yields, both as to quantity and quality.

The other lines of control and investigation work have been followed at the station as heretofore, and satisfactory progress is to be recorded for the year just past.

A constantly growing number of farmers in the State are keeping in touch with the station, by means of correspondence and personal visits. The publications of the station are in great demand, and the editions printed soon become exhausted. It is hoped, for this reason, that a more generous allowance will be made for the printing of bulletins, so that larger editions might be published. A larger appropriation for this purpose will also make possible the printing of a greater number of bulletins on various agricultural topics.

CHEMISTRY.

The work of the chemical department during the year of 1911 has been limited to the fertilizer and feed inspection work, and a study of some methods that have been suggested for the determination of the constituents of fertilizers and feeds.

Fertilizer Inspection.

A part of the fertilizer work was reported in bulletin 240, and the second bulletin containing the balance of the analyses as well as a discussion of the entire inspection is being prepared. The work pertaining to this inspection was increased during the past year by separating what was formerly called "nitrogen from organic matter" into "water soluble organic nitrogen," "active insoluble organic nitrogen" and "inactive insoluble organic nitrogen." The determination of these forms of organic nitrogen required about 3,000 determinations in addition to the large number required for the regular examination. While this extra work has caused a very close application to the work, it is felt that the results obtained are of sufficient value to compensate for the extra effort required.

During the inspection, the total number of samples received was 1,140, about 85 per cent. being collected officially.

The samples analyzed consisted of the following:

514	**samples**	**of**	**Commercial Fertilizer.**	
6	"	"	" "	**(Duplicates.)**
32	"	"	" "	**(Unofficial samples.)**
11	"	"	**Home Mixtures.**	
32	"	"	**Special Compounds.**	
23	"	"	**Miscellaneous Fertilizers.**	
153	"	"	**Fertilizer Materials.**	
42	"	"	**Ground Bone.**	
43	"	"	**Sundry Materials.**	
856	"			

Last year the total number of samples analyzed was 803.

The results of the inspection show that 12.5 per cent. of the guarantees were deficient, and this is the best showing since 1904.

Feed Inspection.

The results of the feed inspection were published under date of April 7th, in bulletin No. 237. During the inspection, 650 samples were received, 630 of which were collected officially. These samples were received from 149 dealers, who are located in 85 cities and towns.

Five hundred and twenty-two samples, representing 414 brands, were analysed. 9.9 per cent. of the samples requiring a guarantee did not satisfy the requirements of the law by carrying the same.

There were 363 samples analysed that required a guarantee, and in 285 samples the guarantees were satisfied. There were 34 samples low in protein, 33 were low in fat and 11 in both protein and fat.

ANIMAL HUSBANDRY.

The executive work of the Live Stock Commission is a part of the duties of the animal husbandman of the Experiment Station, and during the past year his efforts have been directed chiefly toward reviving the horse breeding industry through the organization of horse breeders' associations, and by enforcement of the stallion examining and registration law, which disqualifies from service unsound and undesirable stallions. Through the breeders' associations stallions were distributed for stud purposes, and were mated to such mares as were eligible for service under the rules established by the commission.

A breeders' bureau has been compiled, giving a list of names and addresses of the breeders of pure bred live stock in the State, the number and kind of each breed, and other information of value. This list, when added to and corrected from time to time, will be of great usefulness to the live stock farmers and breeders. A complete report of the workings of the commissioin is published separately and will be distributed through the Experiment Station mailing list.

The work of this department in connection with the College Farm and Experiment Station was interrupted by the destructive fire on July 11th, and only generalized results can be reported. The work was planned as suggested in the last report, increasing the area of corn and alfalfa. The extended dry spell shortened the yield of both crops, but despite the unfavorable season, ensilage and alfalfa proved the most economical base for the dairy ration. Oat and pea silage was provided for late summer use, but the fire destroyed completely the contents of the silo on the day the filling was completed.

The growing of cover crops was continued, rye or wheat and vetch being used, and the increased yield of corn on the Sebolt area, which is traceable entirely to this practice, is quite remarkable and, coupled with results of other years, shows plainly that their use is conducive to economy. A small area was given over to soy beans after oats and peas and suggested a useful rotation.

The prevalence of hog cholera caused great uneasiness among swine growers, and while no funds were available for the manufacture of serum, this department assisted the farmers in guarding against the disease by outlining preventive measures and insisting on clean quarters and complete disinfection and sanitation. In a few cases serum was purchased from other States and furnished at reduced cost to owners of affected herds.

There is in progress an experiment to ascertain the comparative value of tankage and alfalfa as a source of protein to supplement corn meal and wheat middlings in an endeavor to determine a suitable home grown feed for growing and fattening swine. The use of ground oats and peas together with soy beans promises results and will be tested during the coming season.

The dairy herd suffered severe loss through the death of four splendid cows during early spring, and through the summer it was necessary to dispose of several aged cows that had outlived their usefulness. The destruction of the dairy barn and contents by fire necessitated further reduction as suitable quarters for caring for the herd were not available. The remainder of the cows suffered greatly from the excessive heat, as it was necessary to leave them unsheltered in an open yard during the months of July and August. The milk report for the year is consequently relatively low compared with previous reports of this herd. It is therefore impossible to submit useful figures relative to the cost of producing milk under such varied and abnormal conditions; neither is it possible to report experimentally on the relative value of oat and pea silage as compared with green forage or summer corn silage as planned.

HORTICULTURE.

As heretofore, the peach investigations formed the principal line of work of this division. The orchards at Vineland and High Bridge (containing in all about 2,500 trees) are now in full bearing and require much time and attention in the way of observation and the keeping of records. All of the fruit is harvested and marketed under the supervision and direction of this department, and this work demands, therefore, practically the entire time of the horticulturist and his assistants from about August 1st to September 1st.

It is gratifying to note that the experimental orchard produced a good crop of fruit during the past season. This was not generally the case with fruit orchards throughout the State. The net returns from fruit marketed, generally at wholesale, was in excess of $3,100. The fruit was sold in the open market, thus permitting the horticulturist to study problems of transportation and distribution, as well as of methods of packing.

The horticulturist has devoted some of his time to the study of peach diseases and their distribution by means of nursery stock; his observations lead him to believe that this matter will require the attention of fruit growers and nurserymen and will call for the devising of methods of control.

Investigations with carnations and roses were started in a limited way in 1908. These were extended by some co-operative investigations with American Beauty roses in 1910. These co-operative experiments were still further extended in 1911 and have produced results of considerable importance. With these limited facilities gratifying progress was made, and it is expected that experiments will soon be started on a much larger scale, thanks to the appropriation for greenhouses made by our Legislature in the past year.

Other investigations, including fertilizer experiments with standard and dwarf apples, are being conducted at the College Farm. Apart from these the horticulturist and his assistant have given their time to demonstrations on the preparation of self-boiled lime and sulphur sprays of orchards at Vineland and Hammonton.

Exhibits of peaches and of other fruit were also contributed to the Inter-State Fair at Trenton, and to exhibits at Alcyon Park,

N. J., and the Hudson Terminal Building, New York City. The publications of the department within the past year include bulletin 236, entitled "Spraying Experiments With Peaches."

POULTRY HUSBANDRY.

The work of this department may be grouped under three heads:

1. Experimental.
2. Extension.
3. Construction.

1. Experimental.

Owing to limited equipment the experimental work to date has been of a preliminary nature; yet the results point to facts of great practical importance to the poultry raiser. The following are the more important studies carried on:

1st. The need of moisture in artificial incubation and the benefits to be derived from supplying it in the right amount and at the right time.

2d. Dry cracked grain rations for baby chicks was found much superior to wet mash feeding.

3d. Studies in brooder temperatures showed the value of uniform temperature conditions under the hover.

4th. Experiments dealing with the hatching and rearing of chicks brought out the great benefit of an early rather than late hatching and the practical value to be derived from making an early selection of the chicks with regard to the vigor and vitality of the individual. Those which show lack of vitality when young should be disposed of immediately, as they will never make the profitable layer. Free range, shade and green food has been proven, beyond a doubt, to be essential to the proper maturity of pullets.

5th. A study of sprouted oats as a source of succulent green feed for winter use has shown this to be the most economical method of feeding oats.

6th. A detailed study of winter egg production and the accompanying amount and cost of food consumed has given interesting data relating to the much discussed question of the amount of profit which can reasonably be expected per hen per year.

2. Extension.

Owing to a constantly increasing demand from Granges, County Boards of Agriculture and Poultry Associations from many parts of the state for systematic educational work along poultry lines a course of study was outlined, covering twelve months, one lesson each month; the course being available only through organizations already existing. At present there are fourteen organizations taking the work, with a combined total membership of over two thousand.

A permanent educational exhibit has been prepared and exhibited at state and county fairs. In addition to this work, members of the department staff have given lectures throughout different sections of the state covering the results of the work accomplished, and have urged better business management of the state's poultry industry.

Twenty-eight specimens of diseased poultry have been received for determination, and in each case preventative measures and proper treatment have been suggested.

3. CONSTRUCTION.

Much time since May 1st, 1911, has been spent in the planning and the laying out of the new Station Poultry Plant and in erecting the poultry buildings. Most of these have been built by our own staff, thus enabling the keeping of much more accurate records of labor and material as well as the securing of a larger equipment for the money appropriated. One important line of investigation in the future will be the testing out of the different types of houses which have been constructed as to their advantages and disadvantages for laying houses for winter egg production.

SOIL CHEMISTRY AND BACTERIOLOGY.

The report of the present year includes data grouped under the following heads:

I. The Availability of Nitrogenous Materials as Measured by Ammonification.
II. Experiments on Ammonia Formation in the Presence of Carbohydrates and of Other Non-Nitrogenous Organic Matter.
III. Experiments Relating to the Possible Influence of Protozoa on Ammonification in Soils.
IV. Conditions Affecting the Availability of Nitrogen Compounds in Vegetation Experiments.
V. Miscellaneous Vegetation Experiments.

The first of these deals with the study of samples of complete and incomplete fertilizers, in relation to their availability. The results secured confirm those obtained in previous years, and indicate not only that there is a wide range in the availability of nitrogenous materials of animal and vegetable origin, but that the bacteriological method employed brings out the differences between readily available and difficultly available substances. It is also shown by these studies that sodium nitrate, and probably other nitrates, have a tendency to stimulate the decomposition of inert nitrogenous substances. It was found, similarly, that lime, soluble phosphates, various stimulants, and other materials may favor or depress ammonification in soils.

The data grouped under the second title show that dextrose and other sugars may have a stimulating effect on decomposition processes in the soil when present in relatively small amounts. When larger amounts are present ammonia accumulation is depressed. This is in conformity with results reported in previous years. Interesting relations are brought out when different amounts of sugar are used, as well as when different sugars are used. It seems, therefore, that the depressing effect of various carbohydrates on ammonia accumulation in soils is more or less directly related to the chemical constitution of the carbohydrates.

The data dealing with the possible influence of Protozoa on ammonification bear more or less directly on the work published by the Rothamsted Station in England. The experiments carried out in our laboratories failed to confirm the claim made by the Rothamsted Experiment Station that Protozoa are one of the important factors in controlling bacterial activities in soils, and through them the formation of available plantfood. The elimination of Protozoa in some of our experiments failed to increase the ammonifying power of soil infusions or of small quantities of soil.

The collection of data included under the fourth title was secured by means of vegetation experiments in the greenhouse, and also by means of cylinder experiments. The data in question furnished information on various factors that affect the availability of nitrogenous fertilizers in vegetation experiments. They also throw some light on the relation of magnesian and non-magnesian lime to the growth of the crops used in our vegetation experiments. It was made apparent in these investigations that magnesian lime is not only injurious when usesd in relatively large amounts, but that injury is more pronounced in soils containing a large proportion of sand. The cylinder experiments demonstrated that the dilution of heavy silt loam soil by means of sand affects the decomposition of the nitrogenous matter of the soil itself, as well as of that added in the form of dried blood. The addition of sand provides for better aeration and hastens the decomposition of the relatively inert humus compounds. Of the two forms of nitrogen added, namely, nitrate of soda and dried blood, the former was more thoroughly utilized by the crops than the latter except in the soil material consisting of pure sand. In this case the nitrate was evidently leached out to a large extent, and did not give as good returns as did the dried blood.

The miscellaneous vegetation experiments consisted of studies on the influence of lime, gypsum and phosphates on the proportion of protein in soy beans and buckwheat. These experiments consisted in part also of studies on the influence of dextrose on the availability of tri-calcic phosphate, on the influence of lime containing borates, and on the residual effects of lime and carbohydrates used in the preceding year in inoculation experiments with Azotobacter.

Apart from the investigations recorded in the present report, the department of soil chemistry and bacteriology has carried on other cylinder experiments, and field experiments. Some of these will be reported in bulletins or technical papers within the coming year. There are, at present, in the course of preparation two papers that are to be published at an early date. One of these deals with the reciprocal relations of legumes and non-legumes growing in association with one another, while the other deals with the influence of the carbon-nitrogen ratio of organic matter in decomposition processes.

BIOLOGICAL DEPARTMENT.

The report of the biologist is devoted to the consideration of the researches in oyster propagation for which the State continues to make appropriations under the act of 1901, revised in 1907.

The discoveries in this field by the biologist have attracted widespread attention, in respect to their important practical bearings. For example, the Lederle Laboratories have engaged a man who received special instruction in the methods used by the biologist, to conduct similar researches for the benefit of the leading oyster corporation of Connecticut.

The State Bureau of Shell Fisheries prepared a law, which was passed by the Legislature last winter, authorizing a great extension of this work under an oyster observation service, of which the biologist was virtually made codirector with the chief of the bureau.

Apparatus and blank forms, suitable for such a unique service, have been gotten in readiness, awaiting the making of an appropriation to meet the expenses of the service.

The new floating laboratory boat was stationed at Barnegat during the summer. The season proved favorable to oyster propagation and a good catch of oyster seed was produced on our coast generally. But at Barnegat there was no set at all, so that the observations of the station were necessarily limited to a study of the spawning of the adults and of the habits of the fry. The cause of the failure of a "set" at Barnegat can at present only be surmised to have been the extra high temperature attained by the water under the extraordinarily hot weather that prevailed, which exerted special influence on these particularly shallow areas. A definite answer to this and other questions arising out of these researches awaits a comparative study at the different stations which will be established under the new act.

A considerable part of the report of the biologist is devoted to giving detailed directions for conducting the observations required in the new service, and in explaining the methods of study that have been invented by the biologist, for ascertaining the number of oyster fry present in the water on the oyster grounds.

BOTANY.

Plant heredity, plant toxicology, plant sap circulation, plant shading and plant environment have included the main lines of research prosecuted during the past year.

Extensive studies have been continued with tomatoes, and two bulletins were issued during the year, namely: No. 238, "The F_1 Heredity of Size, Shape and Number in Tomato Leaves," Part I, Seedlings; and No. 239, Part II, Mature Plants of the above title; and another bulletin along the same line upon Tomato Fruits is in preparation. The work with the seed cavities of the "Prairie Berry" has included a count of upward of 200,000 fruits, and the results show a decided increase of the seed cavities associated with selection to that end.

Thirteen isolated blocks of corn were grown to secure material for the study of the inheritance, immediate and later, of the seed and other factors.

A hundred commercial varieties of peppers were grown, a knowledge of which sorts was essential for the comprehensive study of the behavior of parents upon offspring in both the pure stocks and the crosses already obtained between them. To this end a record blank has been employed and data of cumulative value secured.

In a similar manner considerable land-space has been given to the continuation of the study of heredity in eggplants and the various classes of beans—not the least of which has been the work upon the hybrids between "American" and "Chinese" eggplants and the "Scarlet Runner" and the common bush beans.

The okras have engaged attention and the study of the hybrids between them and an ornamental species occupied considerable space in the breeding grounds.

In the common sunflower has been found a species that promises well as a subject for researches in both environment and inheritance. It also has proved a good second crop after the crossed peas, and for covering a space where the squashes and gourds were killed in early summer by a near by fire.

During the year an exchange has been made of two acres, distantly located, for a like area lying along side of the "Home Grounds," thus bringing all the land of the department into one field and adjoining the greenhouses, tool and storage rooms, &c.

After seventeen years of service one of the greenhouses has been replaced by a modern structure.

The personnel of the staff has continued the same as last year with the addition of one laboratory aid, thus making five who serve continuously, while during the summer two or more workmen are employed more or less regularly upon the grounds.

The prolonged drought of April and May and the fire in July did considerable damage, but the frosts came very late. However, as a whole the plants did well.

The daily routine of plant determinations, particularly diseases of crops and seed inspection has continued as usual, but the office work has gradually diminished since the discontinuance of the distribution of novelties in cross-bred seeds.

ENTOMOLOGY.

Work in this department has been, in general, conducted along the same general lines as in previous years. There has been the work of the College Experiment Station strictly speaking, in which Mr. E. W. Stafford was appointed assistant for the fiscal year of 1910-1911. Most of the work in this branch is investigational in character, and has been chiefly done by the entomologist or under his personal direction with such assistance as was available from the station at large. Practically all the station bulletins have been issued under this line and, in 1910, Nos. 225 and 229 on Insects Injurious to Strawberries and Sweet Potatoes were so issued. During the fiscal year of 1910-1911 Bulletin No. 235, dealing with

Peach Insects, has been issued in the same way, out of data gathered by the office force, at large, for several years and especially worked over by Messrs. Grossbeck, Dickerson and Mr. Blake's assistants. During the entire summer of 1911 Mr. E. W. Stafford served as assistant in a new study on somewhat radical lines, of the Plum Curculio, and the main feature of the annual report of the entomological department is the outcome from that study—a curiously interesting and not unimportant one.

For many years Mr. Edgar L. Dickerson has been assistant to the State entomologist and, incidentally he has worked gradually into certain lines of investigation work, notably with root-maggots and maggots in general. Mr. Dickerson has recently accepted a position connected with the Newark High School, and his notes on root-maggots and similar pests will be worked into the current reports as fast as anything definite eventuates from them.

Mr. Raymond S. Paterson has been appointed as a regular assistant on the College Experiment Station, and his work has been cumulative, adding here and there as was needed. His ready pen in illustration work will prove of more than casual use and has already added materially to the value of the work with the Plum Curculio already mentioned.

Mr. Harry B. Weiss was added to the staff of the State entomologist in the winter of 1910-1911 and succeeded to Mr. Dickerson's position in September, 1911. The work carried on by Mr. Weiss during the summer is an important one and will be, it is believed, far-reaching. It is nothing less in scope than the general insecticide practice of greenhouse and nurserymen, and its bearing on the agricultural and horticultural practice in our State.

The mosquito work was supported by the State Legislature during the fiscal year ending October 31st, 1911, to the extent of $25,000 as appears by the detailed financial statement hereinafter given, and the character of the work done during the season of 1911 was more typically on the line of that in preceding years. Solid progress was made along the Barnegat shore and a great deal was accomplished by co-operative work with municipalities along the Jersey City and Newark settlements. The importance of both lines of work has been more fully than ever developed, and the almost essential feature of co-operation has been emphasized from all points of view. The mosquito problem stretches in every direction; it is sanitary, agricultural, sociological as well as moral and municipal.

An added function to the entomological department is the apiary inspection work which has just been organized and developed far enough to give a realization of its necessity and importance. Ex-officio, the entomologist of the Experiment Station is inspector of apiaries with all the powers of such. Practically the executive committee of the State Board of Agriculture has the power of appointing and approving as well as of fixing the salaries. For five months Mr. Charles S. Sharp held the position as assistant and then resigned to accept a more satisfactory commercial position.

CHANGES IN THE STAFF.

The untimely death of Dr. Edward B. Voorhees, which occurred on June 7th, has removed from our midst a faithful servant to the agricultural interests in New Jersey. Dr. Voorhees became chemist for the Experiment Station in 1882, and was made director of the State Station in 1892, and of the College Station in 1895. Throughout this time he was zealous in promoting agricultural progress not only in New Jersey but in our sister States.

Another member of the staff, Vincent J. Carberry, died on November 24th at Saranac Lake, New York. Mr. Carberry entered the employ of the Experiment Station in 1894 and proved himself an efficient and conscientious laboratory worker.

The other changes in the staff of the Experiment Station include the resignation of Miner S. Macomber, Walter W. Shute, E. W. Stafford, Julia M. Whitaker.

The following appointments were made:

Harry R. Lewis, poultry husbandman.
Augustine W. Blair, associate soil chemist.
Melville T. Cook, plant pathologist.
Alfred S. Cook, dairy husbandman.
Raymond S. Patterson, assistant in entomology.
Willis H. Pierson, assistant chemist.
Ralph L. Willis, assistant chemist.
Morris Siegel,
Morris A. Halprin,
assistants in poultry.
Mathilde Groth, assistant in plant breeding.
John V. Croot, assistant in the soil department.

REPORT OF THE CHEMIST.

REPORT OF THE CHEMIST.

CHARLES S. CATHCART, M.Sc.

I. *Inspection of Commercial Fertilizers.*
II. *Inspection of Concentrated Feeding Stuffs.*

I.

INSPECTION OF FERTILIZERS.

During the fertilizer inspection for the year 1911, one thousand one hundred and forty-two (1,142) samples were received at the laboratory, and these samples consisted largely of the commercial brands offered for sale in this State and the various fertilizer materials used for making the mixed goods. In addition to these, several samples of home mixtures, special compounds and sundry materials were received and duly reported.

The inspection was as thorough as existing conditions would permit, twenty of the twenty-one counties being visited and samples drawn from the stock of three hundred and sixty-eight (368) dealers and farmers. Eighty-five (85) per cent. of the samples received were collected officially, and the value of the results obtained by the analyses of the remaining fifteen (15) per cent., which were submitted by granges and individuals, would have been greatly increased if they had been collected by an official from this station.

The results of the inspection, with the exception of the unofficial samples of mixed fertilizers that were reported directly to those submitting the samples, were published in Bulletins Nos. 240 and 241. These bulletins contain the analyses and discussion of the following:

514	samples of	Commercial Fertilizers.	
7	" "	" "	(Duplicates.)
32	" "	" "	(Unofficial samples.)
11	" "	Home Mixtures.	
32	" "	Special Compounds.	
23	" "	Miscellaneous Fertilizers.	
153	" "	Fertilizer Materials.	
42	" "	Ground Bone.	
44	" "	Sundry Materials.	
858	"		

The work pertaining to the inspection is constantly increasing; this is not only shown by the number of samples received, but by the number which required an analysis. This year eight hundred and fifty-eight (858) required an analysis, while last year the report shows that the number was eight hundred and three (803), and in 1909 the number was seven hundred and sixty-two (762), which makes an increase of almost one hundred samples in two years. In addition to the increased number of samples examined, during the present year four extra determinations have been made in every sample of mixed goods and five extra determinations in all the samples of fertilizer materials containing organic nitrogen. This extra work required, approximately, three thousand determinations. The object of this extra work was to report some necessary information regarding the character or availability of the organic nitrogen furnished in the fertilizers. The method in force previous to this year gave the percentage content of this constituent, but no information was at hand to show its availability, for it is a well known fact that some of the organic nitrogen found in fertilizers has but little agricultural value. Any information, therefore, that can be given regarding this condition should be of particular value, and we feel that our efforts in this direction have been rewarded by the information obtained, as the results show the need and value of work in this direction.

WHOLESALE PRICES OF THE ESSENTIAL ELEMENTS OF PLANT-FOOD FOR 1910.

The wholesale prices of the unmixed, or raw materials, used in preparing the mixed fertilizers and quoted weekly in the trade journal, "The Oil, Paint and Drug Reporter." In order to express the figures given as prices per pound of actual plant-food, which is the form adopted by the experiment stations of this country, the quotations have been recalculated and tabulated for the entire year. An account of the fact that the report of the station is made on October 30th of each year, the prices that are herewith presented are for the year 1910:

WHOLESALE COST, PER POUND, IN NEW YORK.

MONTHS. 1910.	OF NITROGEN IN FORM OF—						OF PHOSPHORIC ACID IN FORM OF—		OF POTASH IN FORM OF—							
	Nitrate of Soda.		Sulphate of Ammonia.		Dried Blood.		Acid Phosphate.		Kainit.		Muriate of Potash.		Double Sulphate of Potash and Magnesia.		High Grade Sulphate of Potash.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.	cts.
January	13.42	13.26	13.24	13.07	....	18.34	3.00	2.75	....	3.40	....	3.76	....	4.49	....	4.49
February	13.42	13.34	13.44	13.29	18.52	18.22	3.00	2.75	....	3.15	....	3.56	....	4.27	....	4.30
March	13.73	13.50	13.66	13.63	....	18.82	3.00	2.75	....	2.90	....	3.36	....	4.05	....	4.11
April	13.78	13.73	13.90	13.72	20.04	19.73	3.00	2.75	....	2.90	....	3.36	....	4.05	....	4.11
May	13.73	13.58	13.51	13.35	19.28	18.64	3.00	2.75	....	2.90	....	3.36	....	4.05	....	4.11
June	....	13.46	13.41	13.29	....	17.23	3.00	2.75	....	2.95	....	3.45	....	4.22	....	4.29
July	....	13.42	13.29	13.17	17.30	17.00	3.08	2.94	....	3.00	....	3.54	....	4.39	....	4.47
August	....	13.42	13.56	13.39	....	17.73	3.25	3.10	....	3.00	....	3.54	....	4.39	....	4.47
September	13.58	13.42	14.00	13.78	19.55	18.88	3.25	3.10	....	3.00	....	3.54	....	4.39	....	4.47
October	13.74	13.58	14.34	14.17	20.04	19.73	3.25	3.10	....	3.00	....	3.54	....	4.39	....	4.47
November	13.74	13.58	14.51	14.39	20.34	20.00	3.25	3.10	....	3.00	....	3.54	....	4.39	....	4.47
December	13.74	13.58	14.15	13.90	20.28	20.00	3.25	3.10	....	3.00	....	3.54	....	4.39	....	4.47
Average, 1910	13.6		13.7		19.0		3.0		3.0		3.5		4.3		4.4	
Average, 1909	13.7		13.7		16.6		2.9		3.4		3.8		4.5		4.5	
Average, 1908	14.5		14.6		15.4		2.9		3.4		3.8		4.5		4.5	

TRADE VALUES.

As the manufacturers probably place most of their contracts for raw materials near the close of the year, the quotations for the last four months of 1910 and the first two months of 1911 have been considered as a more suitable basis for the determination of trade values for 1911.

Taking these wholesale prices as a basis, the following schedule was arranged at a meeting of the station directors and chemists for use in the New England states and New Jersey for the season of 1911.

SCHEDULE OF TRADE VALUES FOR 1911.

The following schedule of trade values was adopted by the station directors and chemists for use in the New England states and New Jersey for the year of 1911:

	Cents per pound.
Nitrogen in Nitrates	16.00
“ “ Ammonium Salts	16.00
Organic Nitrogen in fine* ground fish meat and blood	23.00
“ “ “ cotton-seed meal and castor pomace	21.00
“ “ “ fine* bone and tankage and in mixed fertilizers	20.00
“ “ “ coarse* bone and tankage	15.00
Phosphoric Acid, soluble in water	4.50
“ “ “ “ ammonium citrate†	4.50
“ “ in fine* bone and tankage	4.00
“ “ “ cotton-seed meal and castor pomace	4.00
“ “ “ coarse* bone, tankage and ashes	3.50
“ “ insoluble in water and in ammonium citrate	2.00
Potash in high-grade Sulphate, and in forms free from muriate (chlorides)	5.00
“ “ Muriate	4.25
“ “ cotton-seed meal and castor pomace	5.00

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* “Fine” signifies such as will pass through a sieve with circular holes $^1/_{50}$ of an inch in diameter and “coarse” such as will not.

† The solubility of phosphates, in ammonium citrate solutions, varies with the degree of heat. An act of the Legislature (see Laws of New Jersey, 1874, page 90), provides that in this determination the temperature shall not exceed 100° Fahr.; in other states 150° Fahr. has been adopted. Consequently, the Station valuation of phosphoric acid, soluble in ammonium citrate, has been fixed at four cents (4c.) per pound for the New England states and at four and one-half cents per pound in New Jersey.

RESULTS OF THE INSPECTION OF MIXED FERTILIZERS.

The samples of mixed fertilizers collected and analysed represented five hundred and fourteen (514) brands, and were the products of one hundred and five (105) manufacturers, if we consider the branches of the American Agricultural Chemical Company separately. The average number of brands per manufacturer is 4.9. There were sixty-one manufacturers represented by this number or less, thirty-three have from 5 to 10 brands, six have from 10 to 15, four have from 15 to 20, and one is represented by 32 different brands.

All of these brands were accompanied by guarantees, although 38 per cent. of them were deficient in their guarantees for phosphoric acid, either the total or available alone being given instead of showing the guarantee for this constituent in both forms. The statement of the guarantee in both of these forms is an important matter when it is desired to have at hand as much information as possible regarding a contemplated purchase. If only the guarantee of the amount that is available is given, the amount that is in the insoluble form is an unknown quantity; if the guarantee for total is the one given, it may be all in the form of insoluble or it may be all available.

In the five hundred and fourteen (514) brands examined there were two hundred and thirty-one (231) different guarantees. Four hundred and thirty-two brands furnished more than 0.20 per cent. nitrogen in the form of nitrates and ammonia salts; two hundred and fifty-one (251) brands contained nitrates; three hundred and forty-seven (347) contained ammonia salts, and one hundred and sixty-six (166) contained both of these forms. Eleven (11) brands contained practically no organic nitrogen, 72.5 per cent. of the brands equaled or exceeded their guarantee for total nitrogen, and in 26 per cent. of these cases the excess was sufficient to at least equal the amount that was found in the "inactive" form. The character of the organic nitrogen as shown in the amount that is soluble in water, the "active insoluble" and the "inactive insoluble" is very important, and a study of the results shows that eighty-six brands contain some nitrogen of low availability, and this number would be increased by twenty if those that are somewhat doubtful are included.

Forty-three (43) brands contained potash in the form of sulphate. Some samples were received which carried a guarantee for sulphate of potash alone; the statement of the guarantee in this form is not only misleading but contrary to the law.

In the brands examined there were one thousand five hundred and forty-two (1,542) deficiencies possible, and of this number one hundred and ninety-three (193), or 12.5 per cent., were found. These deficiencies were distributed among one hundred and seventy-three (173) brands, one hundred and fifty-four (154) of which were deficient in one element; eighteen (18) in two elements and one in the three essential elements. Taken as a whole, these results show that a larger percentage of the brands satisfied their guarantees than has been noted since 1904, when 32 per cent. of the brands and 12.6 per cent. of the guarantees were found deficient.

There were thirty-six (36) deficiencies in total nitrogen, which is the smallest number found in this condition since 1901, when the total number of brands was three hundred and eight (308). If these deficiencies are considered in relation to the number of brands, this is the smallest percentage of brands deficient in this constituent since 1895.

There were one hundred and fifteen (115) deficiencies in phosphoric acid. This large number is undoubtedly due, to some extent at least, to the requirements of our State law in prescribing the temperature at which the reverted phosphoric acid shall be extracted. The number of deficiencies would, perhaps, have been greater if all of the manufacturers calculated the exact amount of phosphoric acid added to the mixtures, but some do not consider the amount of available phosphoric acid that is to be derived from the bone which is a part of the tankage used and thus sometimes add sufficient amounts of this constituent to balance the deficiency caused by our prescribed method.

There were forty-two (42) deficiencies in potash, and this number is a little smaller than found last year.

The average amounts of plant-food guaranteed and delivered in the commercial fertilizers are as follows:

	Average Amount Found.			Average Amount Guaranteed.
	%	%	%	%
Nitrogen from nitrates	....	0.56	....	....
" " ammonia salts	....	0.86	....	....
" " water soluble organic matter	0.36	....	....	....
" " active insoluble organic matter	0.54	....	....	....
" " inactive insoluble organic matter	0.31	....	....	....
" " total organic matter	....	1.21	....	....
" " total (all forms)	....	....	2.68	2.54
Total phosphoric acid	....	9.19	....	....
Insoluble " "	....	1.77	....	....
Available " "	....	....	7.42	7.41
Potash	....	....	6.72	6.27

Average valuation, per ton	$22 58
" selling price, per ton	29 98
" cost of mixing, bagging, etc., per ton	7 40

The following tabulation gives the names and addresses of the manufacturers of complete fertilizers whose goods have been examined this year, as well as a summary of the results obtained. In tabulating these results, a deficiency of 0.20 per cent. in nitrogen, and 0.30 per cent. in phosphoric acid and potash have been disregarded.

SUMMARY OF THE RESULTS OBTAINED WITH THE MIXED FERTILIZERS EXAMINED DURING THE INSPECTION OF 1911.

MANUFACTURER.	ADDRESS.	Number of brands received.	Number of samples examined.	Number of samples satisfied guarantees.	NUMBER OF SAMPLES DEFICIENT IN—					
					Nitrogen.	Phosphoric acid.	Potash.	One element.	Two elements.	Three elements.
American Agricultural Chemical Co.	2 Rector St., New York City	20	22	17	1	3	2	4	1	....
Bradley Branch	92 State St., Boston, Mass	4	4	4	....	....	....	....	....	....
Chemical Co. of Canton Branch	32 South Charles St., Baltimore, Md	1	1	1	....	....	....	....	....	....
Clark's Cove Branch	88 Wall St., New York City	3	3	3	....	....	....	....	....	....
Croker Branch	56 Pearl St., Buffalo, N. Y	3	3	3	....	....	....	....	....	....
Denise and Denise Branch	Freehold, N. J	3	3	1	1	1	....	2	....	....
East India Branch	93 William St., New York City	7	7	7	....	....	....	....	....	....
Great Eastern Branch	Rutland, Vt.	5	5	4	....	1	....	1	....	....
Lambertson & Hance Branch	Freehold, N. J	4	4	3	....	1	....	1	....	....
Michigan Carbon Works Branch	Detroit, Mich.	5	5	4	....	1	....	1	....	....
Milsom Branch	963 William St., Buffalo, N. Y	2	2	2	....	....	....	....	....	....
Moro-Phillips Branch	710 Bourse, Philadelphia, Pa	4	4	3	1	....	....	1	....	....
Packers' Union Branch	150 Nassau St., New York City	3	3	2	....	1	....	1	....	....
Preston Branch	Greenpoint, L. I., N. Y	6	6	5	....	....	1	1	....	....
Read Branch	16 Exchange Place, New York City	5	5	5	....	....	....	....	....	....
Sharpless & Carpenter Branch	710 Bourse, Philadelphia, Pa	6	6	4	....	1	1	2	....	....
Tygert-Allen Branch	2 Chestnut St., Philadelphia, Pa	6	6	6	....	....	....	....	....	....
Wheeler Branch	Rutland, Vt.	4	4	1	....	2	1	3	....	....

Williams & Clark Branch	27 William St., New York City	9	9	7	....	2	....	2	....	....
Acme Guano Co.	Baltimore, Md.	6	6	1	1	4	....	5	....	....
Armour Fertilizer Works	Baltimore, Md.	11	11	5	1	5	....	6	....	....
Warren Atkinson	Mullica Hill, N. J	5	5	5	....	....	....	....	....	....
Atlantic Fertilizer Co.	Stock Exchange Building, Baltimore, Md.	7	7	6	....	....	1	1	....	....
Jas. H. Baird	Marlboro, N. J.	5	5	5	....	....	....	....	....	....
John A. Ballenger	Mullica Hill, N. J	2	2	2	....	....	....	....	....	....
Baugh & Sons Co.	20 S. Delaware Ave., Philadelphia, Pa.	19	19	16	....	3	....	3	....	....
The Berg Co.	Russell and Bath Sts, Philadelphia, Pa.	5	5	2	1	2	1	2	1	....
Beta Fertilizer Co.	Eatontown, N. J	5	5	4	1	....	....	1	....	....
Bowker Fertilizer Co.	43 Chatham St., Boston, Mass.	16	17	15	....	1	2	1	1	....
W. M. Brown	Cedarville, N. J	1	1	1	....	....	....	....	....	....
Chas. Cast	Egg Harbor, N. J	3	3	3	....	....	....	....	....	....
E. B. Chamberlain & Co.	Hightstown, N. J	2	2	1	....	1	....	1	....	....
C. C. Clark and Son	Mt. Ephraim, N. J.	1	1	1	....	....	....	....	....	....
The Coe-Mortimer Co.	51 Chambers St., New York City	12	12	6	....	3	3	6	....	....
J. S. Collins and Son	Moorestown, N. J	5	5	3	....	1	1	2	....	....
Collins & Pancoast	Merchantville, N. J	4	4	3	....	....	1	1	....	....
Consumers Fert. Co.	Farmingdale, N. J.	4	4	4	....	....	....	....	....	....
S. V. Davis	Shiloh, N. J	3	3	2	....	1	....	1	....	....
B. F. Demaris	Cedarville, N. J	6	6	3	1	1	1	3	....	....
H. W. Doughten	E. Moorestown, N. J	2	2	1	1	....	....	1	....	....
The Jas. G. Downward Co.	Coatsville, Pa.	3	3	2	1	....	....	1	....	....
John Dugan	Moorestown, N. J	4	4	2	....	1	2	1	1	....
J. C. Fifield & Son Co.	Northfield, N. J	3	3	2	1	....	....	1	....	....
W. R. Grace & Co.	1 Hanover Square, New York City	1	1	....	....	1	1	....	1	....
Grange Commercial Store	Bridgeton, N. J	3	3	1	....	2	....	2	....	....
Jas. C. Griscom	Woodbury, N. J	2	2	2	....	....	....	....	....	....
Thos. Y. Hackett	Daretown, N. J	2	2	....	2	....	....	2	....	....
Jos. H. Haines & Son	Medford, N. J.	1	1	1	....	....	....	....	....	....
Hendrickson & Dilatush	Robbinsville, N. J	7	7	3	2	....	3	3	1	....
S. M. Hess & Bro.	Fourth and Chestnut Sts., Philadelphia, Pa	7	7	6	....	1	....	1	....	....
Hill and Co.	Flemington, N. J	2	2	1	....	1	....	1	....	....
Hires and Co.	Quinton, N. J.	3	3	3	....	....	....	....	....	....
P. Hoffman & Bro.	Raubsville, Pa.	2	2	1	....	1	1	....	1	....
Hubbard Fertilizer Co.	Merchants Bank Building, Baltimore, Md.	6	6	1	2	3	....	5	....	....
International Seed Co.	Rochester, N. Y.	1	1	1	....	....	....	....	....	....

SUMMARY OF THE RESULTS OBTAINED WITH THE MIXED FERTILIZERS EXAMINED DURING THE INSPECTION OF 1911—Continued.

MANUFACTURER.	ADDRESS.	Number of brands received.	Number of samples examined.	Number of samples satisfied guarantees.	NUMBER OF SAMPLES DEFICIENT IN—					
					Nitrogen.	Phosphoric acid.	Potash.	One element.	Two elements.	Three elements.
Keystone Bone Fert. Co.	15 North Fifth St., Philadelphia, Pa.	7	7	4		2	2	2	1	
S. Lederer & Sons	New Brunswick, N. J.	3	3		3	1	1	1	2	
C. A. Lippincott & Bro.	Moorestown, N. J.	3	3	2		1		1		
Listers Agricultural Chemical Works	Newark, N. J.	19	19	9		10		10		
The Mapes F. and P. Guano Co.	143 Liberty St., New York City	13	13	6	2	5		7		
D. B. Martin Co.	Broad and Chestnut Sts., Philadelphia, Pa.	10	10	3		6	2	6	1	
J. Mickel	Bridgeton, N. J.	1	1	1						
J. E. Minch	Bridgeton, N. J.	4	4	2		2		2		
Monmouth County Farmers' Exchange	Freehold, N. J.	3	3	2		1		1		
Jos. R. Moore	Swedesboro, N. J.	9	9	8		1		1		
Muzzy Bros.	Paterson, N. J.	3	3	1		2		2		
Nassau Fertilizer Co.	5 Beaver St., New York City	8	8	8						
Albert Nelson & Co.	Allentown, N. J.	9	9	6	1	1	1	3		
James E. Otis	Tuckerton, N. J.	1	1		1		1		1	
S. L. Pancoast	Mullica Hill, N. J.	5	5	3	2			2		
Peerless Fertilizer Co.	Chestertown, Md.	2	2	1		1		1		
S. Frank Pennell	Bridgeton, N. J.	1	1			1		1		
Peruvian Guano Corporation	Charleston, S. C.	1	1		1	1			1	

E. G. Peterson	Woodstown, N. J	4	4	3	1	....	....	1	....	....
Rasin Monumental Co.	National Marine Bank Building, Baltimore, Md.	2	2	1	....	1	....	1	....	....
Edward Rigg, Jr.	Burlington, N. J	2	2	2	....	....	....	....	....	....
M. F. Riley	Elmer, N. J	3	3	2	....	1	....	1	....	....
Wm. Rode	Swedesboro, N. J	6	6	3	....	3	1	2	1	....
John B. Rowland	Monmouth Junction, N. J	1	1	....	....	1	....	1	....	....
F. S. Royster Guano Co.	Baltimore, Md.	6	6	6	....	....	....	....	....	....
Ruckman Bros.	New Brunswick, N. J	3	3	1	1	1	1	1	1	....
A. D. Runyon	Millington, N. J	2	2	2	....	....	....	....	....	....
Scott Fertilizer Co.	Elkton, Md.	4	4	4	....	....	....	....	....	....
M. L. Shoemaker & Co.	Delaware and Venango Sts., Philadelphia, Pa.	8	8	6	1	....	1	2	....	....
Shoemaker & Longacre	Swedesboro, N. J	2	2	....	....	2	....	2	....	....
The Rufus W. Smith Co.	Elmer, N. J	3	3	3	....	....	....	....	....	....
South Jersey Farmers' Exchange	Woodstown, N. J	8	8	8	....	....	....	....	....	....
Swift and Co.	Harrison Station, Newark, N. J	6	6	3	....	3	....	3	....	....
Taylor Bros	Camden, N. J	2	2	1	....	1	....	1	....	....
Taylor Provision Co.	Trenton, N. J	3	3	1	1	1	1	1	1	....
I. P. Thomas & Son Co.	1000 Drexel Building, Philadelphia, Pa.	15	16	6	4	5	5	7	2	1
Trenton Bone Fertilizer Co.	Trenton, N. J	10	10	9	....	1	1	....	1	....
F. W. Tunnell & Co.	15 North Fifth St., Philadelphia, Pa.	32	35	16	1	11	10	16	3	....
The J. E. Tygert Co.	28 S. Delaware Ave., Philadelphia, Pa.	6	6	5	....	1	....	1	....	....
Universal Fertilizer Co.	Hackensack, N. J	3	3	1	....	1	1	2	....	....
R. N. Vanneman	Salem, N. J	1	1	1	....	....	....	....	....	....
A. J. Vreeland	Matawan, N. J	1	1	....	....	1	....	1	....	....
Virginia-Carolina Chemical Co.	Richmond, Va.	1	1	....	....	1	....	1	....	....
J. K. Waddington & Sons	Salem, N. J	2	2	....	....	2	....	2	....	....
John D. Wallace	Swedesboro, N. J	2	2	....	1	1	....	2	....	....
Geo. M. Wells	Moorestown, N. J	7	7	6	1	....	....	1	....	....
J. Wenderoth & Sons	Camden, N. J	3	3	3	....	....	....	....	....	....
The West Jersey Marl and Transportation Co.	Woodbury, N. J	6	6	4	1	1	....	2	....	....
W. E. Whann & Co.	William Penn, Pa.	7	7	5	1	....	1	2	....	....
W. Wilde	Vineland, N. J	3	3	1	....	2	....	2	....	....

INSPECTION OF CONCENTRATED FEEDING STUFFS.

The detailed report of the eleventh annual inspection of concentrated feeding stuffs was published in Bulletin No. 237.

During the inspection six hundred and fifty (650) samples of the various feeding stuffs were received at the station, and of this number six hundred and thirty (630) were collected by a representative of the station. These samples represented four hundred and fourteen (414) brands. Five hundred and twenty-two (522) samples were analysed, three hundred and sixty-three (363) of which belonged to the class which requires a guarantee of the content of protein and fat, and the remaining samples belonged to the class not requiring a guarantee. Many of the samples, however, representing the second class were accompanied by a guarantee.

Four hundred and ninety-four (494) of the total number of samples received required a guarantee, and forty-nine (49), or 9.9 per cent., did not satisfy this requirement of the law, and in most of these cases it was ascertained that the manufacturers had shipped the material in bulk, and that the dealer was responsible for the guarantees being missing. In order to obtain the full benefits of the law, it is necessary that every dealer, as well as every consumer, should be fully acquainted with the requirements as enumerated in the law. The station has endeavored to place this information in the hands of every one interested in these materials by publishing the law in bulletins and in circular form.

Three hundred and sixty-three (363) samples requiring a guarantee were analysed this year, and the guarantees were fulfilled in two hundred and eighty-five (285) samples, or 78.5 per cent. This was an improvement over last year when 75.6 per cent. of the samples satisfied the guarantees given. Of the seventy-eight (78) samples that were deficient, forty-four (44) were low in protein and forty-three (43) were low in fat.

Forty-one (41) samples represented feeds that were new to the State and were, therefore, subjected to a complete analysis and, with the exception of one feed, all of these were made according to the general formulas, and need no comment at this time. The one exception was called Hederich Oil Cake Meal, which closely resembles the charlock seed in America, and is sometimes called wild mustard seed. We have been unable to ascertain the feeding value of this material.

THE RELATIVE COST OF FEEDS.

In order to consider the different guaranteed feeds on a more comparable basis the following table was prepared, which shows the actual quantity of protein and fat that was purchased for one dollar:

POUNDS OF PROTEIN AND FAT OBTAINED IN GUARANTEED FEEDS FOR ONE DOLLAR, AT CURRENT PRICES.

	Protein.	Fat.
Class I. (30—40 % Protein).		
Cottonseed Meal	22.4	4.5
Linseed Meal	17.5	3.5
Hederich Oil Cake Meal	22.2	5.9
Class II. (20—30 % Protein).		
Dried Brewers' Grains	20.6	5.0
Baringer's Dairy Feed	20.0	3.0
Crescent Gluten Feed	18.2	2.0
Malt Sprouts	20.8	1.1
Globe Gluten Feed	17.2	2.5
Buffalo Gluten Feed	17.4	2.0
Union Grains, Ready Ration	14.5	4.2
Jenk's Gluten Feed	16.1	2.9
Cream of Corn, Gluten Feed	16.2	2.9
Distillers' Dried Grains	16.7	5.7
Miscellaneous Gluten Feed	15.9	2.9
Husted Dairy Feed	16.4	3.3
Clinton Gluten Feed	15.3	3.6
Husted Molasses Feed	14.3	3.1
Hoosier Gluten Feed	15.0	2.5
Class III. (15—20 % Protein).		
Cedar Rapids Gluten Feed	13.5	3.5
Dried Mixed Grains	15.8	5.8
Protena Dairy Feed	10.2	3.1
Tip-Top Dairy Feed	13.7	12.9
International Dairy Feed	12.2	3.7
Badger Dairy Feed	18.2	2.8
Cottonseed Feed	12.1	2.5
Sugarine Dairy Feed	12.9	3.3
Hammond Dairy Feed	12.9	3.5
Class III. (15—20 % Protein — Cont.).		
Sugarota Dairy Feed	12.0	3.7
Sucrene Dairy Feed	12.2	3.2
International Special Molasses Feed	12.4	3.9
Daisy Dairy Feed	12.1	1.9
Buckeye Mixed Feed	10.6	3.3
Class IV. (8—15 % Protein).		
Barley Feed	11.6	3.5
Quaker Dairy Molasses Feed	10.5	2.7
Holstein Sugar Feed	11.9	3.3
Husted Horse Feed	9.6	3.4
Sucrene Mixing Feed	12.0	3.8
June Pasture Dairy Meal	8.8	0.6
Alfalmo	9.0	0.5
B. and S. Dairy Feed	13.4	7.6
Sucrene Alfalfa Horse and Mule Feed	9.0	2.6
Badger Alfalfa Horse and Mule Feed	8.7	1.7
U. S. Sugar Feed	10.1	3.6
Local Feed Mixture	8.9	3.1
Derby Stock Feed	8.2	3.8
Purina Feed	6.9	2.3
Kornfalfa Feed	6.7	1.7
Perfection Horse Feed	7.3	1.8
Schumacher's Stock Feed	7.8	3.2
Wolverine Horse and Mule Feed	6.7	1.8
Arab Horse Feed	6.5	1.7
Suçrene Horse and Mule Feed	8.0	2.2
Algrane Horse Feed	7.1	3.3

POUNDS OF PROTEIN AND FAT OBTAINED IN GUARANTEED FEEDS FOR ONE DOLLAR, AT CURRENT PRICES—Continued.

	Protein.	Fat.		Protein.	Fat.
Class IV. (8—15 % Protein—Cont.).			**Class IV. (8—15 % Protein—Cont.).**		
Corn Bran	8.0	6.9	No. 1 Chop Feed	6.0	2.2
Hominy Meal	7.8	6.0	Victor Feed	6.2	3.6
Eclipse Feed	7.5	3.6	Dried Beet Pulp	6.6	0.6
Sterling Stock Feed	7.4	3.8	DeFi Feed	6.0	2.7
C. O. and B. Feed	7.9	2.9	Empire Feed	6.4	3.2
Husted Stock Feed	7.1	4.5	Bufceco Stock Feed	6.3	3.9
Corno Horse and Mule Feed	6.5	2.3	Boss Feed	6.3	3.3
Zenith Stock Feed	7.8	3.8	Hominy Feed	6.6	4.9
Schumacher's Special Horse Feed	7.2	2.0			
Grandin's Stock Feed	7.5	3.0	**Class V. (8 % and Less Protein).**		
Husted Molasses Horse Feed	7.2	8.0	P. and S. Feed	5.9	3.0
Mayflower Stock Feed	6.2	3.8	Oat Hulls	7.6	3.4
Germaline	6.6	3.2	Oat Feed	5.9	2.6
Monarch Chop Feed	7.2	4.2	Cob Meal	3.0	0.5

The following tabulation shows the results of the examination of the samples of feed that were accompanied by a guarantee. In preparing this tabulation, the amount of protein found is considered to satisfy its guarantee, provided it is not more than one per cent. below the figure given. An allowance of one-half (0.50) per cent. is also made for the fat:

SUMMARY OF RESULTS OBTAINED WITH SAMPLES OF FEEDING STUFFS THAT WERE ACCOMPANIED BY A GUARANTEE.

MANUFACTURER OR JOBBER.	ADDRESS.	Number of samples examined.	Number of samples satisfied guarantees.	DEFICIENT IN— Protein.	DEFICIENT IN— Fat.	DEFICIENT IN— Protein and Fat.
COTTON SEED MEAL.						
Amer. Cotton Oil Co	New York City	4	2	....	...	2
W. P. Battle and Co	Memphis, Tenn.	2	2	....	...	...
H. E. Bridges and Co	Memphis, Tenn.	1	....	....	1	...
F. W. Brode and Co	Memphis, Tenn.	5	2	3	...	...
Buckeye Cotton Oil Co	Cincinnati, O.	2	2	....	...	...
T. H. Bunch Co	Little Rock, Ark	1	....	....	1	...
Chapin and Co	Buffalo, N. Y	1	1	....	...	...
Humphreys, Goodwin and Co	Memphis, Tenn.	3	3	....	...	...
Hunter Bros. Milling Co	St. Louis, Mo	1	1	....	...	...
Imperial Cotto Milling Co	Memphis, Tenn.	1	....	....	1	...
Memphis Cotton Seed Products Co	Memphis, Tenn.	2	2	....	...	...
J. Lindsay Wells Co	Memphis, Tenn.	4	2	2	...	...
Wilkinson, Gaddis Co	Newark, N. J	1	....	1	...	...
COTTON SEED FEED.						
Southern Fibre Co	Portsmouth, Va.	1	....	1	...	...
OIL (LINSEED) MEAL.						
Amer. Linseed Co	New York City	4	4	....	...	...
Amer. Milling Co	Chicago, Ill.	1	1	....	...	...
Archer-Daniels Linseed Co	Minneapolis, Minn.	2	2	....	...	...
A. L. Clements and Co	New York City	2	2	....	...	...
J. M. Frisch and Co	Baltimore, Md.	2	2	....	...	...
The Guy J. Major Co	Toledo, O.	2	1	1	...	...
The Mann Bros	Buffalo, N. Y	2	2	....	...	...
The Metzger Seed and Oil Co	Toledo, O.	1	1	....	...	...
Midland Linseed Co	Minneapolis, Minn.	1	1	....	...	...
Red Wing Linseed Co	Red Wing, Minn	2	2	....	...	...
Sherwin and Williams Co	Cleveland, O.	1	1	....	...	...
HEDERICH OIL CAKE MEAL.						
Gorgas-Piere Mfg. Co	Philadelphia, Pa.	1	1	....	...	...
GLUTEN FEED.						
American Maize Products Co	Roby, Ind.	2	1	1	...	...
Clinton Sugar Rfg. Co	Clinton, Iowa	2	2	....	...	...
Corn Products Rfg. Co	New York City	7	7	....	...	...
Douglas and Co	Cedar Rapids, Iowa	2	....	2	...	...
Huron Milling Co	Harbor Beach, Mich	2	2	....	...	...
Piel Bros. Starch Co	Indianapolis, Ind.	1	1	....	...	...
F. W. Goeke and Co	St. Louis, Mo	2	2	....	...	...
Keever Starch Co	Columbus, O.	2	....	....	1	1
Sharpless and Bro	Camden, N. J	1	1	....	...	...
C. W. Wagar and Co	Philadelphia, Pa.	1	1	....	...	...
W. T. Will and Son	Philadelphia, Pa.	1	....	1	...	...
D. B. Worman	Philadelphia, Pa.	1	....	....	...	1

SUMMARY OF RESULTS OBTAINED WITH SAMPLES OF FEEDING STUFFS THAT WERE ACCOMPANIED BY A GUARANTEE—Continued.

MANUFACTURER OR JOBBER.	ADDRESS.	Number of samples examined.	Number of samples satisfied guarantees.	DEFICIENT IN—		
				Protein.	Fat.	Protein and Fat.
CORN BRAN.						
M. F. Baringer	Philadelphia, Pa.	2	2	....	...	...
Thompson and Mould	Goshen, N. Y.	1	1	....	...	...
GERMALINE.						
Husted Milling Co	Buffalo, N. Y.	1	1	....	...	...
HOMINY MEAL AND FEED.						
Amer. Hominy Co	Indianapolis, Ind.	2	2	....	...	...
M. F. Baringer	Philadelphia, Pa.	2	1	....	1	...
Empire Mills	Olean, N. Y.	1	1	....	...	...
Evans Milling Co	Indianapolis, Ind.	4	4	....	...	...
Flint Mill Co	Milwaukee, Wis.	1	1	....	...	...
J. A. Howell	Middletown, N. Y.	2	2	....	...	...
Husted Milling Co	Buffalo, N. Y.	1	1	....	...	...
The Lea Milling Co	Wilmington, Del.	1	1	....	...	...
Miner-Hillard Co.	Wilkesbarre, Pa.	1	1	....	...	...
National Feed Co	St. Louis, Mo.	1	1	....	...	...
Patent Cereal Co	Geneva, N. Y.	1	1	....	...	...
The Quaker Oats Co	Chicago, Ill.	1	1	....	...	...
Rogers and Boyd	Mt. Holly, N. J.	1	1	....	...	...
S. F. Scattergood	Philadelphia, Pa.	1	1	....	...	...
I. S. Stover	Philadelphia, Pa.	1	1	....	...	...
Toledo Elevator Co	Toledo, Ohio	3	3	....	...	...
DISTILLERS' DRIED GRAINS.						
B. Devitt	Philadelphia, Pa.	1	1	....	...	...
Hottelet and Co	Milwaukee, Wis.	3	2	....	1	...
Phila. Pure Rye Whiskey Distilling Co	Eddington, Pa.	1	1	....	...	...
C. F. Kech and Co	Milwaukee, Wis.	1	....	....	1	...
DRIED MIXED GRAINS.						
N. J. Sales Co	Newark, N. J.	2	....	....	...	2
BREWERS' DRIED GRAINS.						
Anheuser-Busch Brewing Co	St. Louis, Mo.	2	2	....	...	...
Atlantic Export Co	Chicago, Ill.	1	....	....	1	...
M. F. Baringer	Philadelphia, Pa.	3	3	....	...	...
Deutsch and Sickert	Milwaukee, Wis.	1	1	....	...	...
Du Bois Brewing Co	Du Bois, Pa.	1	1	....	...	...
Francis Duhne, Jr	Milwaukee, Wis.	1	1	....	...	...
Farmers Feed Co	New York City	1	1	....	...	...
Hottelet and Co	Milwaukee, Wis.	3	3	....	...	...
J. C. Klauder, Est	Philadelphia, Pa.	3	3	....	...	...
G. Krueger Brewing Co	Newark, N. J.	2	1	....	1	...
N. J. Sales Co	Newark, N. J.	2	2	....	...	...

SUMMARY OF RESULTS OBTAINED WITH SAMPLES OF FEEDING STUFFS THAT WERE ACCOMPANIED BY A GUARANTEE—Continued.

MANUFACTURER OR JOBBER.	ADDRESS.	Number of samples examined.	Number of samples satisfied guarantees.	DEFICIENT IN— Protein.	DEFICIENT IN— Fat.	DEFICIENT IN— Protein and Fat.
Penn. Grain and Feed Co	Philadelphia, Pa.	2	2	....	...	...
The Roe Co	Branchville, N. J	1	1	....	...	...
Rosenkrans-Snyder Co.	Philadelphia, Pa.	3	3	....	...	...
Schlitz Brewing Co	Milwaukee, Wis.	3	3	....	...	...
R. Stecher Brewing Co	Murphysboro, Ill.	1	1	....	...	...
J. M. H. Walters	Philadelphia, Pa.	2	2	....	...	...
MALT SPROUTS.						
Amer. Malting Co	New York City	1	....	....	1	...
Atlantic Export Co	Chicago, Ill.	2	2	....	...	...
M. F. Baringer	Philadelphia, Pa.	1	1	....	...	...
Hottelet and Co	Milwaukee, Wis.	1	....	....	1	...
John Kam Malting Co	Buffalo, N. Y	1	1	....	...	...
Lambeck and Betz Eagle Brewing Co	Watkins, N. Y	1	....	1	...	...
Geo. J. Meyer Malting Co	Buffalo, N. Y	1	1	....	...	...
Penn. Grain and Feed Co	Philadelphia, Pa.	1	1	....	...	...
Perot Malting Co	Buffalo, N. Y	1	1	....	...	...
Henry Rang and Co	Chicago, Ill.	3	....	1	...	2
Van Vliet Malting Co	Newark, N. J	1	....	....	1	...
E. S. Woodworth and Co	Minneapolis, Minn.	1	....	....	1	...
FEED MIXTURES.						
Alfalfa Meal Co	Council Bluffs, Iowa	1	1	....	...	...
Amer. Milling Co	Chicago, Ill.	7	6	....	1	...
M. F. Baringer	Philadelphia, Pa.	1	1	....	...	...
J. W. Biles	Cincinnati, O.	1	1	....	...	...
Blatchford's Calf Meal Factory	Waukegan, Ill.	1	1	....	...	...
Buffalo Cereal Co	Buffalo, N. Y	1	1	....	...	...
Corno Mills Co	St. Louis, Mo	1	1	....	...	...
Empire Mills Co	Olean, N. Y	2	2	....	...	...
F. A. Goeke and Co	St. Louis, Mo	2	2	....	...	...
D. N. Grandin Milling Co	Jamestown, N. Y	1	....	....	1	...
Great Western Cereal Co	Chicago, Ill.	6	5	....	1	...
The H-O Co	Buffalo, N. Y	3	1	2	...	...
Husted Milling Co	Buffalo, N. Y	16	16	....	...	...
International Sugar Feed Co	Minneapolis, Minn.	3	3	....	...	...
Kornfalfa Feed Milling Co	Kansas City, Mo	2	....	....	2	...
Chas. A. Krause Milling Co	Milwaukee, Wis.	4	2	....	2	...
C. C. Ladd	Minneapolis, Minn.	1	1	....	...	...
Miner-Hillard	Wilkesbarre, Pa.	1	....	1	...	...
North West Mills Co	Winona, Minn.	3	3	....	...	...
Omaha Alfalfa Milling Co	Omaha, Neb.	2	2	....	...	...
M. C. Peters Mill Co	Omaha, Neb.	4	4	....	...	...
Phelps and Sibley Co	Cuba, N. Y	3	2	1	...	...
The Quaker Oats Co	Chicago, Ill.	14	11	2	1	...
Ralston-Purina Co.	St. Louis, Mo	2	1	1	...	...
Rosenkrans-Snyder Co.	Philadelphia, Pa.	1	1	....	...	...
The Sugarine Co	Chicago, Ill.	3	3	....	...	...
Tioga Mill and Elev. Co	Waverly, N. Y	1	....	....	1	...
U. S. Sugar Feed Co	Milwaukee, Wis.	1	....	1	...	...

SUMMARY OF RESULTS OBTAINED WITH SAMPLES OF FEEDING STUFFS THAT WERE ACCOMPANIED BY A GUARANTEE—Continued.

MANUFACTURER OR JOBBER.	ADDRESS.	Number of samples examined.	Number of samples satisfied guarantees.	DEFICIENT IN— Protein.	DEFICIENT IN— Fat.	DEFICIENT IN— Protein and Fat.
Western Grain Products Co	Hammond, Ind.	8	8	....	...	...
Wolverine Feed Co	Battle Creek, Mich	1	....	....	1	...
ALFALFA MEAL.						
Amer. Milling Co	Chicago, Ill.	1	1	....	...	...
The Albert Dickinson Co	Chicago, Ill.	1	1	....	...	...
Kornfalfa Milling Co	Kansas City, Mo	1	1	....	...	...
M. C. Peters Milling Co	Omaha, Neb.	1	1	....	...	...
Ralston-Purina Co.	St. Louis, Mo	1	1	....	...	...
Otto Weiss Alfalfa Stock Food Co	Wichita, Kan.	1	....	1	...	...
Wichita Alfalfa Stock Food Co	Wichita, Kan.	1	1	....	...	...
BARLEY FEED.						
Allen V. Smith	Marcellus Falls, N. Y	1	1	....	...	...
DRIED BEET PULP.						
The Larrowe Milling Co	Detroit, Mich.	4	4	....	...	...
U. S. Sugar Co	Madison, Wis.	1	1	....	...	...
GRANULATED MILK.						
Geo. L. Harding	Binghamton, N. Y	1	....	....	1	...
LOCAL FEED MIXTURES.						
Belvidere Flouring Mill Co	Belvidere, N. J	2	2	....	...	...
Frank Bird	Stanton, N. J	1	....	....	1	...
A. Cyphers Co	Newark, N. J	1	1	....	...	...
Eber De Cou	Pemberton, N. J	1	1	....	...	...
C. C. Dempsey	Gloucester, N. J	2	....	1	1	...
Jos. English Co	Paterson, N. J	1	1	....	...	...
Jos. Gardner	Dover, N. J	2	2	....	...	...
Holley and Smith	Hackensack, N. J	1	1	....	...	...
The Ingersoll Co	Hamburg, N. J	1	1	....	...	...
C. H. Leonard	Boonton, N. J	1	1	....	...	...
Long Dock Mill and Elev. Co	Jersey City, N. J	1	1	....	...	...
The McMurtrie Co	Belvidere, N. J	1	1	....	...	...
Meyer and De Vogel	Paterson, N. J	1	1	....	...	...
P. O'Blenis	Paterson, N. J	1	1	....	...	...
C. A. and T. P. Reed	Pennington, N. J	1	....	1	...	...
The Geo. Richards Co	Dover, N. J	2	2	....	...	...
L. B. Risdon Milling Co	Trenton, N. J	2	2	....	...	...
Sitley and Son, Inc	Camden, N. J	8	1	....	...	2
J. C. Smith and Wallace Co	Newark, N. J	1	....	....	1	...
Taylor Bros.	Camden, N. J	2	2	....	...	...
Wiegand Milling Co	Newark, N. J	1	1	....	...	...
Worman Mills	Frenchtown, N. J	1	1	....	...	...

SUMMARY OF RESULTS OBTAINED WITH SAMPLES OF FEEDING STUFFS THAT WERE ACCOMPANIED BY A GUARANTEE—Continued.

MANUFACTURER OR JOBBER.	ADDRESS.	Number of samples examined.	Number of samples satisfied guarantees.	DEFICIENT IN— Protein.	Fat.	Protein and Fat.
POULTRY FOODS.						
J. S. Collins and Son	Moorestown, N. J.	1	1	....	...	...
E. W. Conklin and Son	Binghamton, N. Y.	2	2	....	...	...
Cyphers Incubator Co	Buffalo, N. Y.	1	1	....	...	...
A. Cyphers Co	Newark, N. J.	4	4	....	...	...
Edwards and Loomis	Chicago, Ill.	1	1	....	...	...
Geo. L. Harding	Binghamton, N. Y.	1	1	....	...	...
E. Hollingshead	Moorestown, N. J.	1	1	....	...	...
The H-O Co	Buffalo, N. Y.	3	3	....	...	...
Husted Milling Co	Buffalo, N. Y.	4	2	....	2	...
International Sugar Feed Co	Minneapolis, Minn.	1	1	....	...	...
Park and Pollard Co	Boston, Mass.	1	....	1	...	...
Puritan American Poultry Food Mfg. Co.	Bound Brook, N. J.	2	2	....	...	...
The Quaker Oats Co	Chicago, Ill.	2	2	....	...	...
Ralston-Purina Co.	St. Louis, Mo.	1	....	....	1	...
Wilkinson, Gaddis Co	Newark, N. J.	3	3	....	...	...
The Geo. Richards Co	Dover, N. J.	1	....	....	1	...
Simpson Bros.	Norristown, Pa.	1	....	....	1	...
Sitley and Son, Inc	Camden, N. J.	1	1	....	...	...
Taylor Bros.	Camden, N. J.	6	6	....	...	...
MEAT MEALS AND BEEF SCRAP.						
The Berg Co	Philadelphia, Pa.	1	1	....	...	...
Blatchford's Calf Meal Factory	Waukegan, Ill.	1	....	1	...	...
The Bowker Fertilizer Co	New York City	2	....	1	1	...
The Flavell Co	Asbury Park, N. J.	1	....	1	...	...
The Fritz Co	Philadelphia, Pa.	1	....	1	...	...
C. A. Lippincott and Bro	Moorestown, N. J.	1	1	....	...	...
The Park and Pollard Co	Boston, Mass.	1	1	....	...	...
D. W. Romaine	Jersey City, N. J.	1	....	1	...	...
Sharpless and Bro	Camden, N. J.	1	....	1	...	...
M. L. Shoemaker and Co	Philadelphia, Pa.	1	1	....	...	...
Sitley and Son, Inc	Camden, N. J.	1	....	1	...	...
Spratt's Patent	Newark, N. J.	1	1	....	...	...
Swift and Co	Harrison Sta., Newark, N. J.	2	....	2	...	...
Syracuse Rendering Co	Syracuse, N. Y.	1	1	....	...	...
Taylor Bros.	Camden, N. J.	1	....	1	...	...
The Van Iderstine Co	Long Island City, L. I.	1	1	....	...	...
WHEAT BRAN.						
Ballard and Ballard Co	Louisville, Ky.	1	1	....	...	...
Daisy Roller Mills	Milwaukee, Wis.	1	1	....	...	...
Duluth Superior Milling Co	Duluth, Minn.	1	1	....	...	...
W. J. Jennison	Minneapolis, Minn.	1	1	....	...	...
Listman Mill Co	La Crosse, Wis.	1	1	....	...	...
Milbourne Mills	Philadelphia, Pa.	1	1	....	...	...
National Feed Co	St. Louis, Mo.	1	1	....	...	...
Northwestern Con. Milling Co	Minneapolis, Minn.	1	1	....	...	...

SUMMARY OF RESULTS OBTAINED WITH SAMPLES OF FEEDING STUFFS THAT WERE ACCOMPANIED BY A GUARANTEE—Continued.

MANUFACTURER OR JOBBER.	ADDRESS.	Number of samples examined.	Number of samples satisfied guarantee.	DEFICIENT IN— Protein.	DEFICIENT IN— Fat.	DEFICIENT IN— Protein and Fat.
Pillsbury-Washburn Mill Co.	Minneapolis, Minn.	1	1	....	...	...
Red Wing Milling Co.	Red Wing, Minn.	1	....	1	...	...
WHEAT MIDDLINGS.						
Atlas Flour Mills	Milwaukee, Wis.	1	1	....	...	...
Amsted and Burk Co.	Springfield, O.	1	1	....	...	...
Berger, Crittenden Milling Co.	Milwaukee, Wis.	1	1	....	...	...
B. A. Eckhart Milling Co.	Chicago, Ill.	1	1	....	...	...
W. J. Jennison	Minneapolis, Minn.	1	1	....	...	...
Lawrenceburg Roller Mills Co.	Lawrenceburg, Ind.	1	1	....	...	...
Northwestern Con. Milling Co.	Minneapolis, Minn.	1	1	....	...	...
Red Wing Milling Co.	Red Wing, Minn.	1	1	....	...	...
Sheffield-King Milling Co.	Minneapolis, Minn.	1	1	....	...	...
Washburn-Crosby Co.	Minneapolis, Minn.	1	1	....	...	...
FEEDING FLOUR.						
Berger, Crittenden Milling Co.	Milwaukee, Wis.	1	1	....	...	...
Eagle Roller Mills Co.	Minneapolis, Minn.	1	1	....	...	...
Red Wing Milling Co.	Red Wing, Minn.	1	....	....	1	...
Washburn-Crosby Co.	Minneapolis, Minn.	1	1	....	...	...
WHEAT FEED.						
The Allen and Wheeler Co.	Troy, Ohio	1	1	....	...	...
Hunter-Robinson-Wenz Milling Co.	St. Louis, Mo.	1	1	....	...	...
Kehlor Flour Mill Co.	St. Louis, Mo.	1	1	....	...	...
Noblesville Milling Co.	Noblesville, Ind.	1	1	....	...	...
Russell-Miller Milling Co.	Minneapolis, Minn.	1	1	....	...	...
Sparks Milling Co.	Alton, Ill.	1	1	....	...	...
Star and Crescent Milling Co.	Chicago, Ill.	1	1	....	...	...
RYE FEED.						
M. F. Baringer	Philadelphia, Pa.	1	1	....	...	...
R. P. Koenig and Co.	Watertown, Wis.	1	1	....	...	...
WHEAT AND RYE.						
Mauser Mill Co.	Treichlers, Pa.	2	2	....	...	...
OAT FEED.						
John J. Campbell	Hartford, Conn.	1	....	....	...	1
F. K. Fish	New York City	1	1	....	...	...
The McMurtrie Co.	Belvidere, N. J.	1	1	....	...	...
Tilson Co.	Tilsonburg, Canada	1	1	....	...	...
OAT HULLS.						
Canadian Cereal and Milling Co.	Toronto, Ont.	1	1	....	...	...

MARKET PRICES OF COMMERCIAL FEEDING STUFFS.

	AVERAGE FOR THE SIX MONTHS PRECEDING.				
	May 1. 1907.	May 1. 1908.	May 1. 1909.	May 1. 1910.	May 1. 1911.
Cottonseed Meal	$33.67	$33.28	$33.82	$36.63	$35.70
Linseed Meal	34.43	35.69	35.58	35.75	39.84
Gluten Feed	27.06	31.22	32.31	32.54	28.88
Hominy Meal	24.88	30.76	30.40	29.90	26.80
Maizeline Feed	26.50	32.00	32.00	34.00	....
Corn Bran	24.17	31.00	29.00	29.00	26.60
Corn Meal	23.46	29.52	31.91	30.25	26.64
Corn and Oats	24.83	30.22	32.28	29.50	26.75
Cob Meal	21.50	23.67	26.67	27.00	18.75
Wheat Feed	23.73	30.00	28.93	29.33	27.50
Wheat Bran	24.17	29.20	27.40	27.65	27.56
Wheat Middlings	25.50	31.46	29.75	29.61	29.90
Feeding Flour	28.90	34.00	37.50	31.70	33.00
Rye Feed	23.33	30.60	30.33	30.00	25.50
Rye Bran	20.75	28.25	26.00	26.00	24.75
Rye Middlings	23.67	29.00	29.43	27.28	26.80
Buckwheat Feed	17.36	28.67	24.50	20.00	25.00
Buckwheat Bran	23.00	22.00	25.00	18.00	23.33
Buckwheat Middlings	22.07	28.75	27.82	28.20	26.36
Barley Feed	21.50	29.00	....	26.50	25.00
Dried Distillers' Grains	27.50	29.50	32.00	27.50	27.43
Malt Sprouts	20.60	25.92	27.00	26.00	25.45
Dried Brewers' Grains	22.87	28.91	28.20	28.31	26.82
Alfalfa Meal	31.00	37.80	38.50	33.86	33.75
Dried Beet Pulp	21.10	25.21	25.00	25.55	26.21

REPORT OF THE ANIMAL HUSBANDMAN.

REPORT OF THE ANIMAL HUSBANDMAN.

HORSE BREEDING.

The animal husbandman of the Experiment Station is ex-officio secretary and executive officer of the Live Stock Commission and a member of the Stallion Examining and Registration Board. The work as provided by this special legislation was directed chiefly toward reviving the horse breeding industry of this State; for in years past New Jersey was noted for its excellent horses and famous Thoroughbreds through the many prize winning animals bred and developed within the State.

As the result of legislation relative to the activities of questionable sportsmen, together with the recognition and development of profitable agricultural resources, there seemed to be a general movement among the farmers and breeders toward the growing of money crops—potatoes, tomatoes and other market garden products—causing a lull in horse breeding operations. A demand was created for a heavier type of horse suitable for more difficult farm work, the carting of heavy loads to our markets, and the operating of heavier machines. Since the prices of Western horses at the market centers were so very high this department suggested that an attempt be made to interest the farmers in breeding a more profitable and marketable type of farm horse, that he might become more independent of the dealer who supplied unacclimated, high priced geldings (mostly) for farm work. In cases where farmers had adhered to the utility type of farm horse they were able to command from $50 to $100 more per animal for their New Jersey grown horses of equal merit; and the business farmer was not slow in making the most of such an opening.

There being a scarcity of draft stallions of modern type and relatively few real draft mares the problem was many sided. Few breeders desired to invest money in valuable draft stallions with the known scarcity of useful brood mares; still there seemed to be a willingness on the part of the farmers to secure mares, if provision could be made for breeding stallions. A substantial appropriation was made by the Legislature to be used in purchasing suitable stallions for distribution and use through breeders' associations, thus enabling owners of approved mares to obtain at small expense the services of appropriate stallions for producing useful farm horses. In addition to providing breeding sires a further step was taken toward eliminating from stud service mongrel or unsound stallions by a personal examination of every stallion offered for public service by the Stallion Examining and Registration Board.

The first assemblage of stallions in the various counties three years ago brought out for examination many inferior and unsound stallions; and, furthermore, many of the better bred ones were presented in bad condition. They had had little or no exercise, and their feet were badly neglected, as they were literally stall fed stallions. The board by refusing certificates to inferior or unsound stallions, and by urging better care with more exercise from their caretakers, had a greatly improved lot for inspection at the next advertised examination. This is true in every county where the examinations were made. The stallion owners take pride in presenting their charges in the best possible breeding condition, as mare owners as well as stallion owners make it a point to be present at the annual inspection, and to compare the merits and conformation of the various stallions.

Foals, the get of the imported sires, are now coming to the age of usefulness. In November, 1911, a Grade Clydesdale filly, owned by Linden Rigby, of Raritan, N. J., and sired by "Rosseau," the Clydesdale in service in Somerset county, sold as a yearling at public auction for $252; while instances are many where owners of the foals refuse to put a price on their youngsters. Intense interest in the many colt shows was manifested by the high class and number of the entries, and the competition for prizes offered, not only by the commission, but by public spirited citizens who have exhibited unusual interest and have been of valuable assistance in reviving this important industry.

A detailed report of the workings of the commission, including a complete list of the names and addresses of the breeders of pure bred live stock in the State, as well a classified list of owners of licensed stallions; also the activities along other lines of live stock breeding, feeding, management and general improvement, has been prepared by the secretary and issued as a separate publication which will be sent to any address upon request.

A brief summary of the results, however, may be given as follows:

1. Ten stallions were supplied by the State for stud purposes through breeders' associations providing approved mares for service; the cost to mare owners being the actual cost of maintenance of the stallion throughout the year, and ranged from $5 to $15 per foal.

2. Mares rather than geldings or mules are now purchased by members of the breeders' associations, and in many cases three or four light roadster misfits have been replaced by two draft blood mares and an equal amount of farm work accomplished at a reduced cost for maintenance.

3. The importance of raising for farm work the class and type of horse most useful and readily marketable—one whose weight fixes his value rather than his speed record—is more generally recognized among active breeders and farmers, and utility rather than mere beauty or speed is the guiding factor in selection of mares and stallions.

4. By requiring annual examination and inspection of stallions, and maintaining high standards of individual excellence, as well as fixed requirements as to breeding and soundness, relatively few grade or inferior young stallions are kept for stud purposes. The board is very rigid in licensing young stallions, so that few owners care to bother with a stud colt until he is three years of age if there is any likelihood of being refused a certificate through failure of the animal to qualify as to breeding and individuality.

5. A surprisingly large number of stallions of questionable usefulness have been emasculated during the past three years, inasmuch as the mare owners, encouraged by the commission, are demanding that stallions shall hold pure bred or blue certificates, rather than the yellow ones indicating grade or cross bred animals. Blood tells, and the mare owners know the difference between reasonable certainty and mere chance.

6. Renewed interest and activity relative to the use of pure bred sires and more carefully selected females resulted from extension work through the breeders' associations and personal assistance in the choosing of breeding stock. There is great promise of marked improvement in live stock breeding operations through this later method.

7. The matter of hog cholera was investigated and assistance given outlining preventative methods, advocating clean quarters and complete sanitation; while serum was purchased and distributed at cost. It is hoped that provision will be made for the manufacture and distribution of serum by the Commonwealth.

8. A breeders' bureau was compiled giving the names of breeders of pure bred live stock in the State; their location, number of animals and other valuable information for live stock farmers and breeders who desire to purchase additional specimens or dispose of their surplus breeding animals.

9. The question of profits with sheep in this State was investigated, and outlines for successful management provided. North Jersey particularly was found to possess vast areas especially suited to profitable sheep farming.

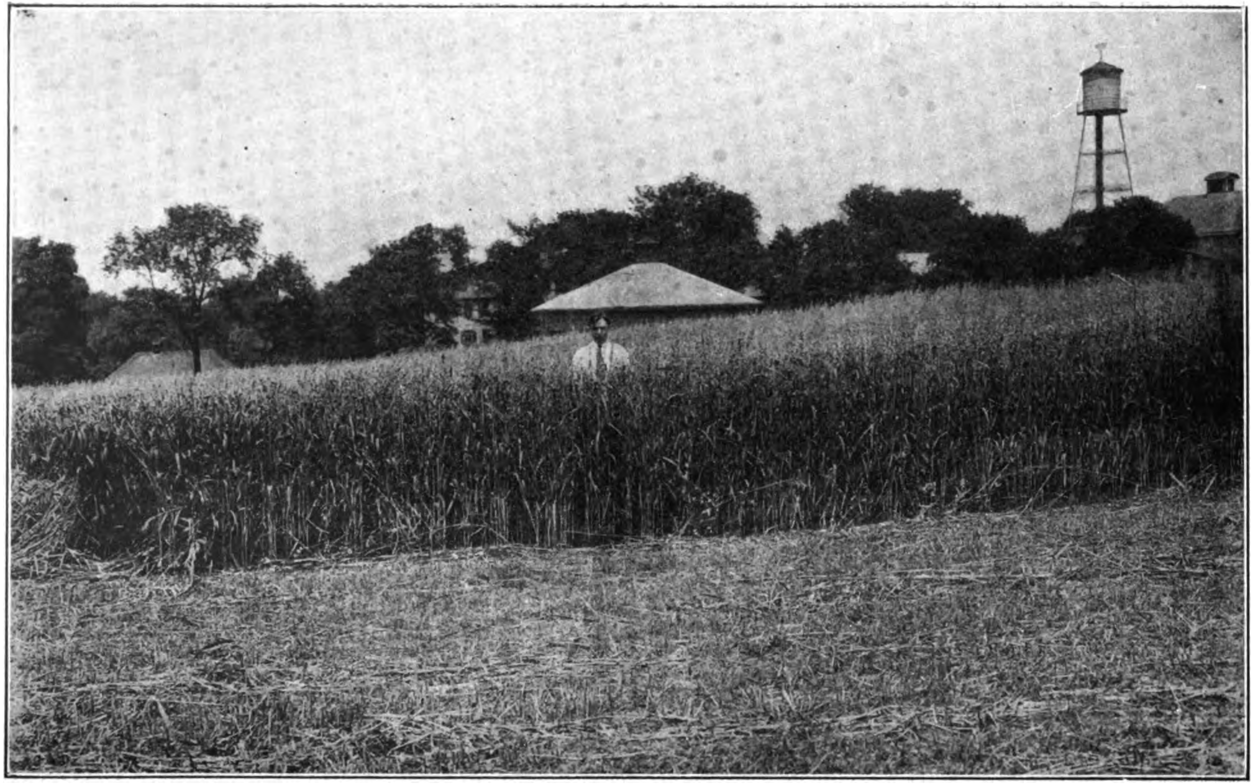
10. Plans were arranged for the formation of cow testing associations and swine leagues; the object being to assist in the selection and breeding of sires and matrons not only with horses but other classes of live stock as well.

COLLEGE FARM AND STATION—GENERAL REMARKS.

The work of this department during the past year pertaining to the College Farm and Experiment Station was continued along the same general lines as outlined last year. The relatively small area of the College Farm available for the growing of general field crops is decreasing each year, as it becomes necessary to add new departments as well as increase the area devoted to the regular Experiment Station departments. Corn and alfalfa constituted the major crops, while oats and Canada field peas, cowpeas and kaffir corn, rye or wheat and vetch, soy beans and mixed hay were produced in small quantities. That corn for ensilage grain and fodder, and alfalfa for forage and hay should be the chief crops produced for the dairy herd was arranged three years ago, hence the increased area devoted to these two crops.

The planting season opened late, the ground being cold and unusually wet during early spring; while a severe and long continued dry spell checked the growth of all plants during midsummer. Notwithstanding these unfavorable conditions the yield of ensilage corn was larger than usual, averaging 9.7 tons for 22 acres ensiled.

The alfalfa plants were unusually late in starting growth, due no doubt to the severe and most unfavorable winter season. The plants, especially in the low spots of the ten acre field heaved very badly; thousands of the roots being dislodged and killed. In many cases the ground was completely covered with bare unattached roots and rootlets, and it was common comment that portions of the field at least would require reseeding. Such was not the case, however, as a great many seemingly loose plants took root (or literally grew at the end of long exposed roots) so that relatively few bare spots are to be found in the field. The advantage of using an abundance of seed at the time of seeding, thus insuring a thick stand, with plants to spare, was fully demonstrated, and in my judgment is largely responsible for the good condition of the field at this time. Lime was also an important factor, as where



Oats and Canada Field Peas. Ready to cut for threshing July 8th.

an abundance of this product was spread the heaving was less noticeable, even though the ground was equally low and wet.

An attempt was made in 1910 to compare the relative value and economy of using oat and Canada field pea silage during the months of July, August and September. A sufficient area was seeded to provide green forage and in addition fill the small silo which holds about 60 tons. The oats and peas made a very satisfactory growth, and were run through the regular ensilage cutter into the silo. Just as the last acre was being harvested, on July 11th, the farm buildings and silos were completely destroyed by fire, and since the ensiled mass had not fully settled, the damage from smoke spoiled the entire heap, and the loss was complete. The rotation provided for soy beans to follow the oats and peas, but the extra work caused by the fire made it impossible to prepare the ground for planting, and cowpeas and kaffir corn were drilled in on part of the stubble. The high cost of cowpeas made this crop an expensive one this year, yet the mixture of cowpeas and kaffir corn makes a splendid dairy forage, if seeded in time to make sufficient growth before frost. The soy beans were planted in rows three feet apart, after rye harvested for bedding, and while they have not been thrashed at this time, it is evident that they will prove a valuable crop.

The growing of two legume crops on the same area during the same season seems possible where oats and Canada field peas are planted early, and the soy beans follow; and with such a system in practice the farmer would not only have home grown protein in abundance, but his land would gain in both fertility and production. Ground oats and peas make a most excellent feed for all young and growing stock; while the oat and pea straw is as valuable as hay, providing it is cured bright and carefully mowed away. There is great promise in this combination, especially in South or Central Jersey, particularly for the live stock farmer. Any crop that will supply succulent green forage, palatable hay, nourishing grain and satisfying roughage, and at the same time add nitrogen to the soil—all this, and in addition, ripen sufficiently early (July 1st) to permit the growing of another money crop such as soy beans is almost on a parity with alfalfa. Some difficulty was experienced with the pea louse, but where the crop is harvested in season there is little loss from these sap suckers.

All of the corn fields together with other available areas were seeded with a cover crop mixture of rye or wheat and winter vetch to be used either as early forage, green manure or bedding; the plan being to have every acre of ground engaged in growing some crop throughout the year, rather than permitting a waste of plant food through leaching or washing, as is the case when fields are left bare during the fall and winter months. The cost is relatively small, ranging from $1.25 to $2 per acre, while the gain in humus, nitrogen and the improvement of physical properties of the soil is of inestimable value. Experience prompts the purchase of the vetch seed early in the season as the growing popularity of its use as a cover crop generally, invariably causes a shortage of seed and consequently increases the cost.

FODDER CORN AND ENSILAGE.

A number of new varieties of ensilage corn were tested and compared with the Southern White type that has been used at the farm for several years past. Twenty rows of each variety were planted on the Sebolt area, where field conditions were similar, and the following yields and varieties are identified:

Variety.	Total yield of 20 rows. Tons.	Lbs.
Horse Tooth	13	420
Woods Virginia Ensilage	13	490
Eureka	13	1,910
Pamunkey	12	610
Shenandoah White Dent	10	270
Cockes Prolific	13	810

As there was a very slight variation in the length of the rows the following comparison gives their relative yields per acre:

Variety.	Tons per acre.
Horse Tooth	11.2
Woods Virginia Ensilage	11.2
Eureka	11.8
Pamunkey	10.4
Shenandoah White Dent	8.52
Cockes Prolific	11.35

Of the above six varieties, the "Eureka" proved to be the heaviest yielder by weight; gave a larger percentage of leaves to stalk, and was on the whole the most satisfactory variety of silage corn; however, it would be necessary to plant this variety early in May in order to have it well matured as is desirable for the best silage.

"Cockes Prolific" is a very strong growing variety, the stalks standing up well. The fodder was a trifle coarse, and while it was very leafy it was poorly eared. "Pamunkey" corn was similar to the "Cockes Prolific" in habit of growth, having an unusually tall straight stalk, but was poorly leaved, and did not have as many ears in proportion to the stalks as is desirable. "Horse Tooth" produced a very heavy stalk, but was late maturing, and did not seem to have the root development to resist the wind as it blew down badly, while the other varieties escaped injury.

"Woods Virginia Ensilage Corn," while somewhat similar to the "Horse Tooth," exhibited hardier habits of growth, and although the weight was exactly the same per acre, it displayed a much larger proportion of foliage.

"Shenandoah White Dent" was the earliest maturing variety of the six. It stood up well and displayed by far the greatest proportion of ears. The low yield in tons was largely due to the fact that it was much riper than any of the other five at time of harvesting.

In general, it may be said that the standard variety, Southern White, seed of which has been purchased from a Virginia grower, averages well with varieties tested and is widely grown in New Jersey. Four acres were planted with a variety known as "Monmouth Yellow," supplied by Lew Jones of Red Bank, and intended for ensilage; but as the area was wet it was necessary to let the corn ripen. The ears were especially large, the stalks late in maturing, but the total yield excelled the others tested.

As noted in the general remarks the growing season was backward, and early planted corn was slow in germinating. A total of 41 acres was planted to corn, 22 acres of which was cut for silage, and the balance ripened for fodder. Owing to delay in erecting the new temporary silos, filling was not commenced until the first week in October; and even then excessive and continued rains and unfavorable weather made it impossible to use the corn harvester, and the bulk of the cutting was done by hand. The upland portions of both fields were harvested first, and thus it was necessary to use intended fodder corn for ensilage and vice versa. The corn ensiled was well cured, some of the varieties being sufficiently matured for husking. The proportion of dry matter in well cured corn is larger, but the danger of having frosted ensilage through delay in cutting the crop must be considered.

A test sample of "Cattle Corn" was secured from A. F. Wheaton, of Bridgeton, and the acre yielded 8.3 tons of excellent feed early in September. The same strip in 1910, planted with a variety known as "Golden Ruby" secured from Edward Shute, yielded 8.2 tons. These early maturing leafy, juicy stalked varieties were very well suited for early cutting as green feed for cattle and swine, as both ripened very early and were practically cured when harvested during early September.

As late as June 25th the Triangle was planted with "Hill Acres Best," a leafy white dent corn, grown and supplied by Richard Wais, of Lebanon, a member of the E. B. Voorhees Agricultural Society. Its growth was remarkable, and the yield equally as satisfactory; the four acres producing 31 tons, 450 pounds of silage. A total of 217 tons of ensilage was stored in the two new silos, an average of 9.7 tons per acre, as compared with 7.7 tons in 1910.

USE OF SLUDGE.

A carload of sludge, the residue from glue manufactories and leather tanneries was applied to strip plots in the corn field; also to one acre of oats and peas. It unfortunately happened that the wet weather made it impossible to harvest the entire strips of corn treated, and with the oats and peas, half of the field was harvested on the day of the fire. Since the scales were destroyed comparative yields with the check plots cannot be given; however, notes made during the growing season show that where this material was applied at the rate of two tons per acre there was more stimulated growth of young plants; they displayed a richer green color, and the increased foliage with the corn, likewise, the greater size of the oat and pea stalk, together with the evident increase in yield of both, prove that this product has value, and that the nitrogen contained therein is in a useful form. Not only was there a difference noted in the growth of the major crops, but where a cover crop—rye and vetch—was seeded in the corn at the time of the last cultivation, the effects of the lime contained in the sludge were evident as the strips across the fields were plainly

Alfalfa field ready for seeding, after Oats and Canada Field Peas harvested as green forage.

visible, and the vetch in particular shows a thicker stand, better color and generally more vigorous growth. It will be interesting to note the effect of the sludge on crops to follow. The sludge was distributed by means of the manure spreader, and was easy to handle, and if received in large quantities may be easily stored in unprotected heaps.

ALFALFA.

The yields of alfalfa were lower than last year, the seventeen and one-half acres yielding an average of 5.15 tons per acre. The first cutting for hay, on June 6th, from the eleven acre field totaled 23.6 tons; the second cutting, on July 16th, 16 tons; the third cutting, on August 12th, 11 tons, and the last cutting, on September 25th, 6.1 tons. The extra work incident to the fire made it difficult to properly handle the crop, it being necessary to stack out the second and third crops. Four acres were seeded on August 22d, making a total of 21 acres of alfalfa on the farm at this time. Two acres seeded in August, 1910, on areas that have grown alfalfa more or less since 1898, demonstrated anew the importance of thorough inoculation as well as the value of lime, as the present stand is by far the most complete of any previously reported from these fields. The six year old alfalfa field withstood the dry weather much better than later plantings; but as the stand is gradually diminishing the field will be plowed and reseeded during the coming year. A great deal of inoculating material, screened soil, was freighted to various parts of the State, and if taken as an index as to the area seeded, shows conclusively that dairymen, especially, are increasing the acreage of this forage crop in their endeavors to lower the cost of milk production. In several instances especially large plantings were made, the New Jersey Alfalfa Land Company, seeding 169 acres, and the Walker-Gordon-Farms over 150 acres, the latter being for the most part seeded after early ensilage corn.

OATS AND CANADA FIELD PEAS.

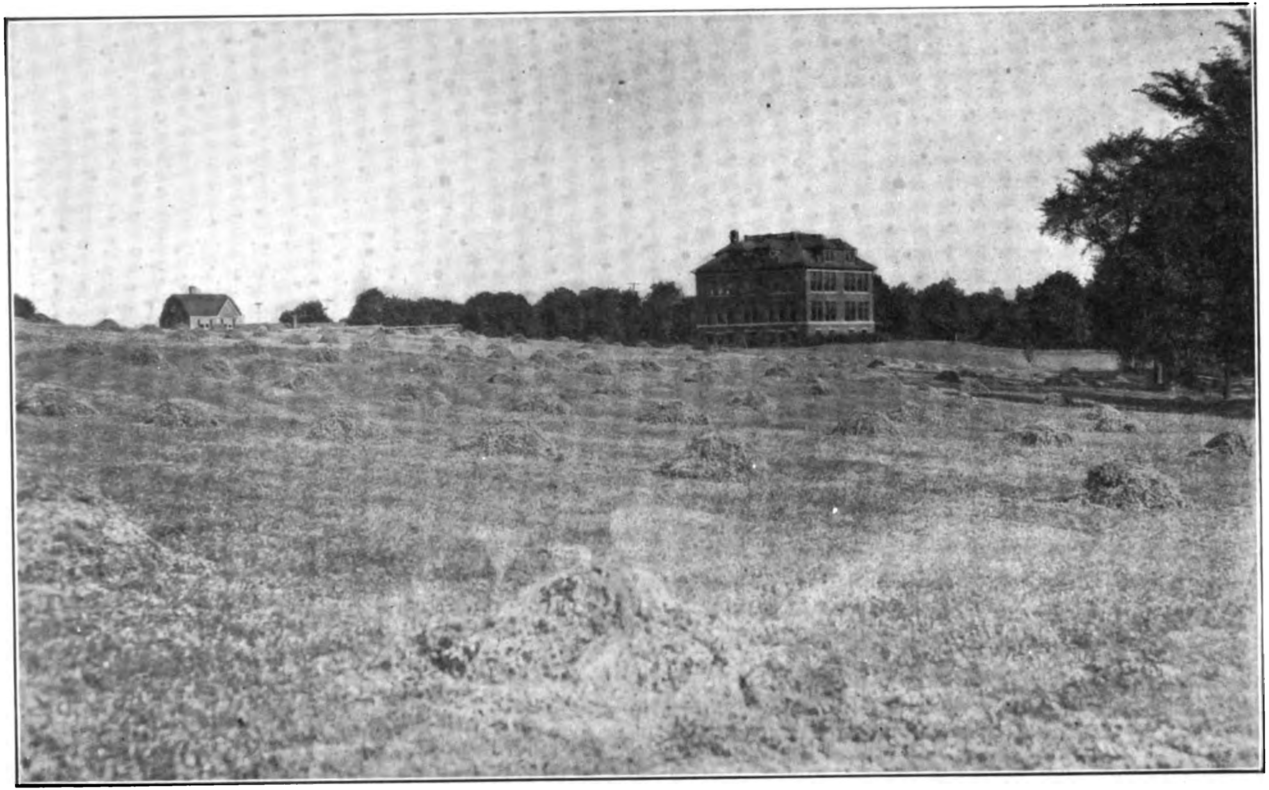
The rotation provided for eleven acres of oats and Canada field peas. Seven acres yielding 43.3 tons of green forage, which was run through the Ohio cutter, put in the silo on July 6th to 11th.

As stated elsewhere the entire mass was damaged by fire, it being possible to feed only a small portion found in the center of the silo. The experience this year, together with the results of the practice last year, shows that where it is impossible to store sufficient corn silage for summer use that oats and peas make a splendid silage, although the yield per acre is less and the cost per ton greater. It further shows that it is more economical to ensile the oats and peas rather than cut green and feed daily as green forage; first, because it enables seeding of the entire area at one time rather than at successive intervals of 10 days each; second, because the crop can be harvested when reaching ripeness and maturity rather than making the first cutting when the plants are too green and the last cuttings when the crop is too ripe, as is the case under the soiling system; third, the early plantings are not troubled with the pea louse as is the case with later plantings; fourth, the feed is equally as palatable, costs less to handle and is more convenient, as rainy days and wet ground greatly interfere with satisfactory every day cuttings, and fifth, one is able to have the use of the ground at an earlier period thus enabling the planting of a summer crop such as soy beans, cowpeas and kaffir corn, oats and barley or any other crops suited to the farmer's need.

It must not be forgotten that oat and pea hay ranks high in feeding value, and is especially suited to the feeding of horses—particularly idle horses or those whose winter work is irregular. It serves both as grain and roughage, is bulky and nourishing and is far superior to timothy hay or even mixed hay. Young growing stock thrive on the ground oats and peas and relish the straw and pea vines after threshing. It is doubtful if oats should be grown in New Jersey without the field peas if the greatest profits are desired. The nitrogen gathering property of the peas not only supplies food for the oats but substantially enriches the soil.

SOY BEANS, COWPEAS AND KAFFIR CORN.

An acre of soy beans (Ito San) was planted on June 25th after rye had been cut for use as bedding. This is rather late for seeding this crop to insure podding and ripening before frost, but a small amount of fairly plump beans were gathered. Planting can best be done with an ordinary garden planter in rows 18 inches



Alfalfa. Fourth crop harvested September 22d, 1911. Yield, 1.4 tons per acre.

or two feet apart, unless a regular two row bean planter is available, rather than with a corn planter which runs rows at least three feet apart, causing waste land as well as a weedy crop unless expensive methods of cultivation are practiced. If it is possible to grow a money crop of soy beans after a crop of oats and peas on the same area a very successful rotation is at hand.

The kaffir corn and cowpeas were mixed, 1 bushel of peas with 14 quarts of kaffir corn per acre, and drilled on oat and pea stubble late in July. The peas just out of cold storage were badly infested with maggots and continued dry weather was not favorable for prompt germination and the stand was poor. The yield in partially cured forage, slightly frosted, from the four acres averaged six tons per acre. The one acre facing the dairy stable was also seeded with cowpeas and kaffir corn after oats and peas, used as green forage, had been harvested, the same being run in the silo with the corn. The yield was 9.9 tons of splendid forage.

Considerable trouble was experienced in attempting to cure cowpeas and kaffir corn during the late fall, and our experience prompts their use either as green forage or as silage.

MIXED HAY.

The new seeding of grass made in August of last year on the eleven acre field that has been devoted to the growing of corn, exclusively for the past ten years, yielded a total of 27.6 tons of fine hay. The one acre that had not received any barnyard manure for ten years produced an inferior grade of hay as well as a smaller quantity. But little variation was noted in the yield of the three acre plots that have been treated during this period with different mixtures of commercial fertilizer, the object of which was to determine the most economical source of phosphoric acid. A top dressing of barnyard manure was made during the winter months over the entire field and was largely responsible for the vigorous growth of second crop hay. It has been the practice during the past year to spread the barnyard manure on either the meadow or those fields supporting a cover crop, thus deriving full value of the nitrogen. Unfortunately the mixed hay, together with approximately 50 tons of alfalfa hay was completely destroyed by the fire. It is hoped that the area of alfalfa can be substantially increased and thus enable the cutting down of the area now devoted to the growing of mixed hay for use as horse feed.

COVER CROPS.

It is gratifying to report continued success with winter vetch as a cover crop. The practice of seeding just previous to the last cultivation of the corn, a mixture of rye, vetch, crimson clover, and cowhorn turnips was instituted three years ago. Some difficulty was experienced at the outset in obtaining a satisfactory stand of vetch, due no doubt to a lack of inoculation, as continued plantings of vetch on the same fields during the past two years have resulted in most satisfactory stands of the legumes, and when the cover crop was plowed under in the spring the soil was found to be full of nodules clinging to the roots of the vetch plants. Wheat and vetch have proved a more satisfactory mixture for use as early green forage for the dairy herd, as the cutting period is longer, the forage more palatable than is the case where rye is used as the companion crop. Care must be exercised, however, in plowing under a cover crop of this description as it is necessary to plow the ground before the rye reaches sufficient maturity to hinder rapid decomposition. When a mixture of rye, vetch and crimson clover is made there is less danger from failure to secure satisfactory stands.

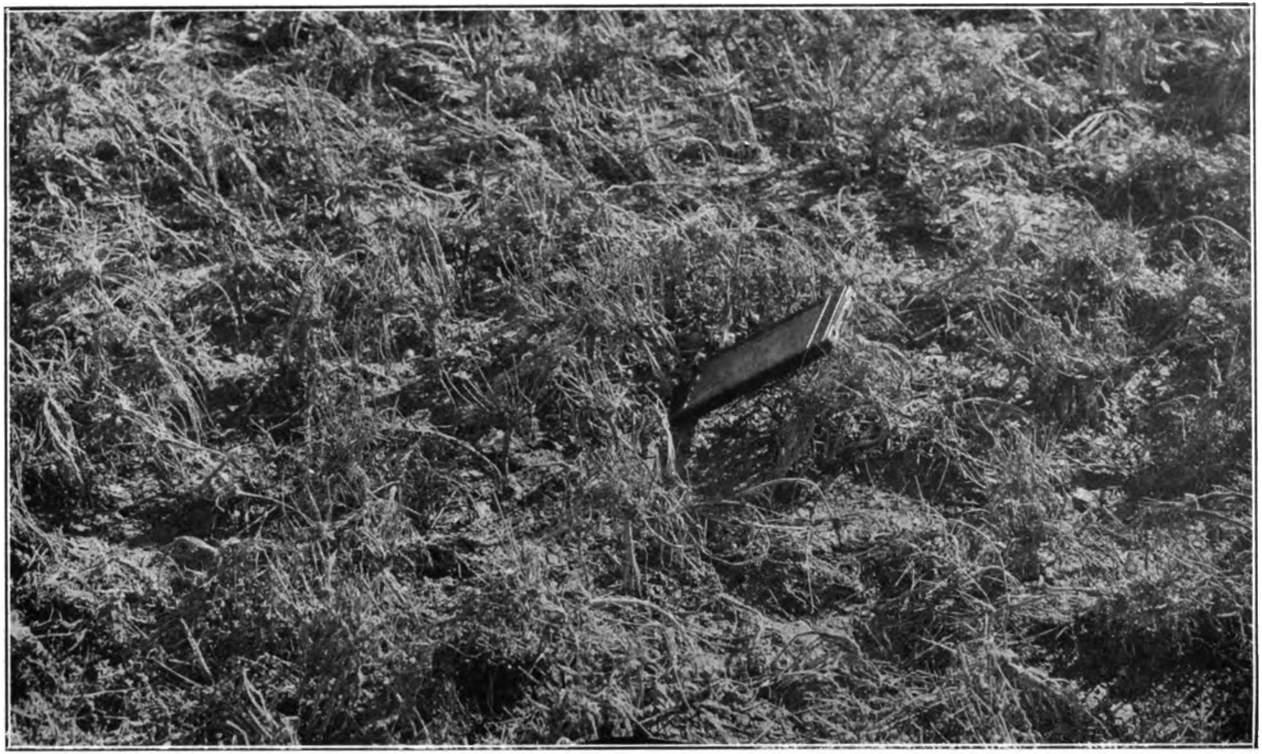
COVER CROP MIXTURE.

Rye or Wheat	60 lbs.
Winter Vetch	15 "
Crimson Clover	8 "
Cow Horn Turnip	2 ozs.

per acre; seeded broadcast in corn just previous to the last cultivation, either with a Cahoon Seeder or by hand on horseback.

WORK WITH SWINE.

The swine herd is now composed of pure bred animals entirely, the last of the grades being marketed during the spring of 1910. The present group of Berkshires are the direct descendants of two



Alfalfa Roots "heaved" very badly. Note some entirely uprooted; however, the stand was average and the yield 5 tons per acre of cured hay.

UNIV. OF I

Masterpiece sows purchased in 1909, while the Yorkshires were all bred on the farm.

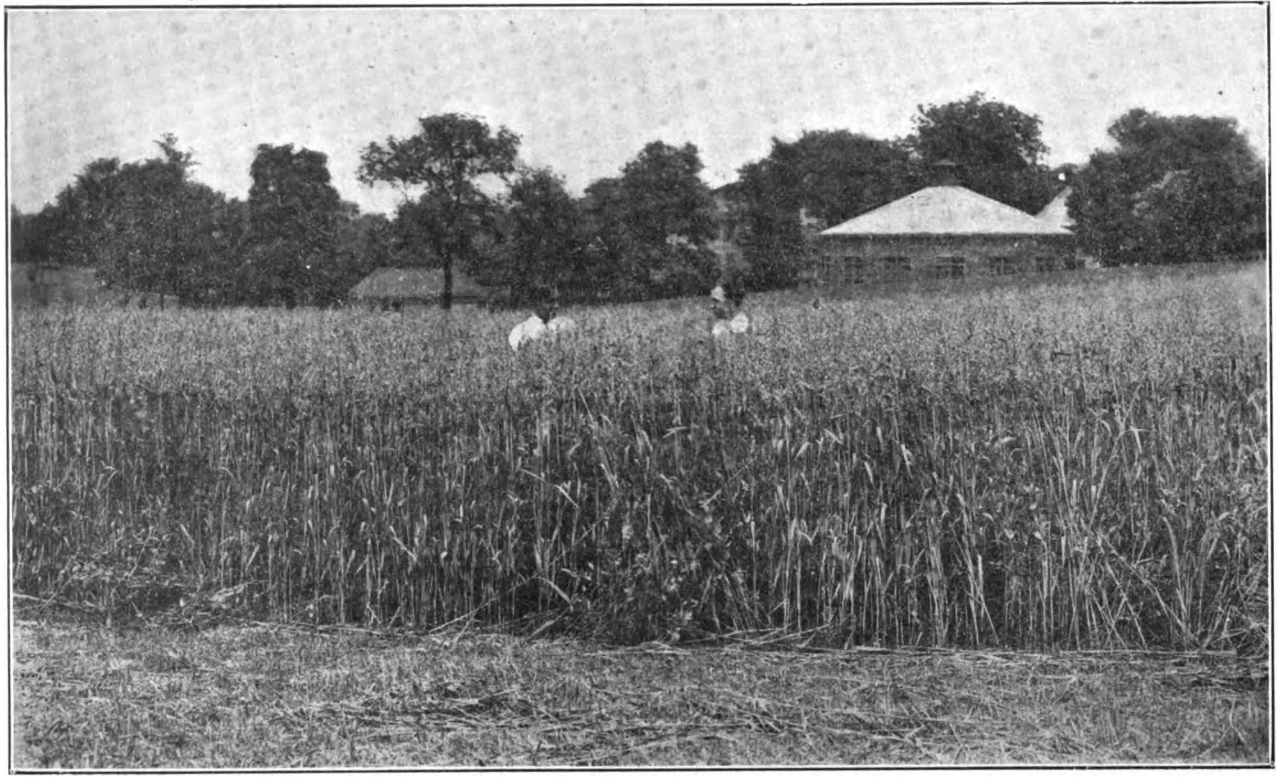
An experiment is in progress, the object of which is to determine the value of alfalfa as a feed for swine; *i. e.*, in the way of furnishing protein, as compared with digester tankage. Corn meal and wheat middlings constitute the base of both rations, with alfalfa hay in the one case and tankage in the other supplying the protein. It is believed that alfalfa will prove an economical feed for swine, especially where the pasture areas are restricted or absent entirely, as is the case at the College Farm. A small field seeded with a mixture of rape, oats and peas was used for the brood sows during early summer, but the bulk of the herd was entirely pen fed with forage crops, supplemented with purchased feeds. Some splendid types are available for judging work, and the herd has been an unfailing source of profit since the present sanitary quarters were established. Two areas of two year old alfalfa will be fenced and pastured during the coming year and more extensive investigation work outlined. The prevalance of cholera especially along the shore counties has caused great loss and uneasiness among swine growers, and it is hoped that immunizing serum can be produced and distributed next year. Preventative methods are helpful, but when a real outbreak occurs, immediate steps must be taken toward obtaining serum, if the spread of the disease is to be checked. Many states are producing serum very economically; New Jersey should show the same activity. A number of bred sows and registered males were furnished farmers and breeders at low cost in order to encourage, and revive activities producing marketable swine. Definite assurance that serum could be obtained in case of cholera would greatly increase the number of swine herds in the State.

THE DAIRY HERD.

The short courses provided new and modern equipment for the handling of the market milk produced by the dairy herd, and now all the milk is cooled and bottled at the short course building. The old dairy house did not have adequate facilities for cooling and storing the product, and the new arrangement is most agreeable. The students will have more practice in actual handling of the milk under the present arrangement.

The dairy herd suffered material loss during the year. Pneumonia caused the death of "Patty Sharpe" and "Perfection," while a complicated case of milk fever accompanied by prolapse of the uterus failed to respond to treatment, and "Buttercup," the leader of the herd in butter fat during the past two years, succumbed. The Guernsey cow "Alice" died of acute indigestion during early spring. Such misfortune, followed by the burning of all dairy buildings, July 11th, necessitating additional sale of animals, due to inadequate quarters, and a desire to dispose of few aged cows that had finished their usefulness, was most unfortunate. The remainder of the herd suffered greatly from exposure to the heat, as it was necessary to let them remain in unsheltered yards during July and August. The flies were especially annoying, the heat intense, and the milk records correspondingly low. Twelve of the cows were stabled at milking time at Mr. James Neilson's place, but during the day they were quartered in open yards. Nine heifers were put out to pasture during early June, and remained until October 1st. This group of youngsters will be bred to freshen next September, and will materially add to the present milking herd. There has been a growing demand for grade heifer calves, sired by the pure bred bulls, maintained at the station and out of the heavier milking cows. Dairymen more fully recognize the importance of raising heifer calves from profitable cows as a source of restocking their dairies, rather than depending on the dealer for stock cows.

The milk and butter fat records of all cows remaining in the herd during the full year are given below, as well the average daily product in pounds of milk for the balance of the herd, together with the number of days in milk. The general average of the entire herd is relatively low as compared with previous reports of the same cows due to the many irregularities mentioned.



No. 1.

Oats and Canada Field Peas. Ready to harvest for use as hay, July 2d.

FULL YEAR COWS.

Record of College Farm Herd.
December 1st, 1910, to November 30th, 1911.

Stable No.	Name.	Breed.	No. of Days in Milk.	Total No. Lbs. of Milk.	Average % Butter Fat.	Total Lbs. Butter Fat.	Total Lbs. Estimated Butter.
4	Primrose	G H	313	10,685.1	3.58	382.58	446.32
6	Miss Kinnie...............	G H	285	12,603.2	3.83	479.26	559.13
12	Lizzie	G H	361	11,668.4	3.68	429.29	500.81
13	Modesty	G J	242	5,873.5	4.56	268.04	312.71
20	Diana	G H	280	11,375.2	3.82	434.90	507.37
22	Primrose 2nd..............	G H	311	10,026.4	3.68	368.77	430.21
23	Mattie of Cold Spring 2nd,	P-b J	297	10,520.3	4.99	524.66	612.08
24	Beauty Girl...............	G J	323	7,422.0	6.0	445.45	519.65
25	Manda King 2nd...........	P-b J	252	5,894.8	4.86	286.17	333.84
26	Long A Coming 4th.......	P-b G	292	6,637.7	5.36	355.88	415.16
28	Princess Mate.............	G H	298	11,207.1	3.49	390.64	455.71
30	Coral Roselle..............	P-b G	362	6,332.1	5.01	322.33	376.02
33	McLaury's Gift...........	P-b J	283	5,842.2	5.40	321.07	374.55
34	Colantha 3rd..............	P-b H	338	13,594.6	3.56	484.55	565.27
	General Totals........		....	129,782.6	....	5,493.59	6,408.83
	Average for 14 head...		303	9,270.2	4.28	392.40	457.77

Average for 1 day 30.5 lbs., or 14.2 qts. for each day in milk.
Average for 365 days 25.4 lbs., or 11.9 qts per day.

The above shows seven Holsteins averaging 11,594.3 pounds of milk for the year, testing 3.66 per cent. fat; five Jerseys with an average of 7,130.6 pounds of milk, testing 5.20 per cent. fat; two Guernseys yielding 6,484.9 pounds of 5.39 per cent. milk, or a total of fourteen head of milch cows milking for an average period of 303 days out of 365, and yielding a general average of 9,270.2 pounds of milk and 457.77 pounds of estimated butter.

HEIFERS IN MILK WITH THEIR FIRST CALVES.

(All bred on the Farm.)

Stable No.	Breed.	Name.	No. of Days in Milk.	Total No. Lbs. of Milk.	Average % Butter Fat.	Total Lbs. Butter Fat.	Total Lbs. Estimated Butter.
1′	H	Princess 2nd.................	179	5,303.2	4.03	213.77	249.38
2′	H	Patty Sharpe 2nd...........	229	6,672.0	3.63	242.48	282.89
15′	J	Manda King 2nd............	171	3,953.6	5.02	198.58	231.67
17′	A	Eva Douglass...............	116	3,994.8	4.01	160.15	186.84
21′	A	College Lassie...............	297	6,327.4	4.07	257.28	300.14
		General Totals...........	992	26,251.0	....	1,072.26	1,250.92
		Average for 5 head......	198	5,250.2	4.9	214,55	250.18

Average for each day in milk 26.5 lbs.; equivalent to 12.3 qts. milk per day.

It will be noted that none of the heifers were in milk during the full year, that is, none of the youngsters finished their full lactation period. The showing is remarkably good, and they give promise of developing into cows of greater milking ability than their dams whose records will be found in previous reports of this department. It is evident that this system of rearing one's own calves on the farm is by far the best practice to follow, especially in dairy sections where shipments from other states are the only animals available, for too many times they are the culls from other herds and often carry latent or active disease germs.

RECORD OF COWS RETAINED IN THE HERD DURING A PART OF THE YEAR ONLY.

December 1st, 1910, to November 30th, 1911.

Stable No.	Name.	Breed.	No. of Days in Milk.	Total No. Lbs. of Milk.	Average % Butter Fat.	Total Lbs. Butter Fat.	Total Lbs. Estimated Butter.
2	Patty Sharpe..............	P-b H	35	1,108.3	3.6	39.71	463.3
3	Merry Maiden.............	P-b H	103	1,420.8	4.06	57.72	67.32
5	Ruberta	G H	285	8,185.7	3.33	282.75	329.86
7	Nellie Barstow............	G H	138	4,015.2	3.07	123.48	143.98
8	Lillie White..............	G H	240	11,511.7	3.41	392.24	457.59
9	Miss Johnson..............	G H	138	4,015.2	3.07	39.71	46.33
9'	Dutchess	G H	238	9,019.6	3.43	309.03	360.52
10	Pauline Paul..............	G H	218	7,984.4	3.55	283.10	330.27
11	Daisy	G H	238	7,938.9	3.65	289.16	337.33
11'	Loutillie	G H	121	2,267.1	3.71	84.05	98.05
14	Matilda	G J	83	1,000.0	4.82	48.23	56.26
15	Buttercup	G J	53	718.1	5.6	40.29	47.00
16	Dolly	P-b A	26	569.7	3.7	21.07	24.58
17	Eva Woodruff.............	P-b A	197	6,314.6	3.73	235.77	275.05
18	White Lassie..............	P-b A	121	2,202.1	4.11	90.47	105.55
19	Cherry	P-b A	232	5,078.7	3.8	193.02	225.16
21	Bessie	G H	35	924.5	3.4	31.32	36.53
27	Miss Pierce...............	G H	259	7,779.1	3.37	262.30	305.98
29	Lillian Wall..............	A R G	90	1,297.8	4.47	58.07	67.78
31	Hilda 2nd.................	G H G	31	743.1	3.6	26.75	31.21
32	Alice	G G	42	1,208.8	5.22	63.14	73.66
21	Total		2,747	81,551.9	....,	2,940.21	3,420.98
	Average		131	3,825.6	3.6	....	....

Average for 1 day 29.7 lbs., or 13.8 qts. per day.

The rations fed did not differ materially from those reported last year, as detailed feeding experiment work was not carried out due to the unsettled conditions resulting from the fire. Ten tons of mixed feeds were fed along at intervals of six weeks, but they failed to prove as palatable as the home mixture, and the milk flow was decreased rather than increased. Several of the cows failed to partake eagerly of the mixed feeds, and dropped in their milk flow. The cost per ton was the same as the home mixed ration; while the latter produced more milk. Ensilage in abundance was available as it was possible to utilize portions found in the center of the silos destroyed by fire.

All of the first crop of alfalfa was destroyed by fire together with 15 tons of the 1910 product, and the later cuttings, stacked in open stacks, did not furnish choice feed. The experience with oat and pea silage is given under the heading of oat and Canada field peas. This crop has been grown for several years in increased quantities, and is especially recommended as a source of succulent palatable feed to supplement pastures during June and July, in order to keep up the flow of milk during this trying period.

There are many economic problems relative to live stock production demanding attention, and under the new arrangements the animal husbandman is relieved from the detailed management of the College Farm and dairy herd, and will devote his entire time during the coming year in an attempt toward determining actual conditions affecting live stock farming and suggest helpful methods designed to be of use and service to farmers producing live stock and their products.

REPORT OF THE HORTICULTURIST.

REPORT OF THE HORTICULTURIST.

MAURICE A. BLAKE, B.S., *Horticulturist.*
ARTHUR J. FARLEY, B.S., *Assistant Horticulturist.*

The peach investigations which have been conducted on an extensive scale since 1906 are still the most important feature of the work of the horticultural division. During the past season a large crop of fruit has been harvested, which has afforded an opportunity to make practical tests of various methods of handling and packing the fruit for shipment.

One bulletin has been published during the past year, New Jersey Experiment Station Bulletin No. 236, "Spraying Experiments With Peaches."

The soil and fertilizer investigations with carnations and roses, which were started at the College Farm in 1908, have been continued during the year, and, although the greenhouse facilities have been limited, much progress has been made.

An appropriation of $11,000 has been made available during the year for the construction and equipment of greenhouses for investigational work, and the department will be much better equipped another year for conducting its work along floricultural lines.

The co-operative experiments with American Beauty roses, which were started in 1910, have been extended and continued in 1911.

The fertilizer experiments with standard and dwarf apples at the College Farm and the strawberry tests have been continued as in previous years.

The weather observations for the season of 1911 have been in the charge of Mr. George Thrasher.

PEACH EXPERIMENTS AT HIGH BRIDGE.

The season at High Bridge was the most favorable one that the experiment orchard has experienced. Mountain Rose was practically a failure as was the case at Vineland, and throughout the State, but Greensboro, Carman, Hiley, Ray, Belle of Georgia and Elberta produced good crops.

The midseason varieties were affected by the drought, but rains came in time to provide ample moisture for Elberta. This variety, however, was below normal in flavor for the High Bridge section of the State. Cool, dull weather prevailed for a number of days just previous to the ripening of this variety, and it was much more acid than usual. Elberta also has a slight bitter taste under some conditions, and this was noticeable the past season at High Bridge. Weather conditions play an important part in the coloring and ripening of fruits, and this is more clearly indicated in a season such as the past, where extremes of temperature and moisture prevail.

The trees in the experiment orchard at High Bridge were sprayed with lime-sulfur for the control of the scale and leaf curl, and later with arsenate of lead for the control of the curculio. The spraying was apparently very effective against the latter insect and no damage was observed.

A larger proportion of trees have been destroyed in this orchard because of yellows and little peach than at Vineland. All the trees of two varieties had to be removed before the trees produced fruit and were undoubtedly diseased when received from the nursery. Other individual cases appeared the second and third summer after planting, and new cases have appeared each year since. Thus far, the plots receiving the best fertilizer treatment have suffered the least from these two diseases.

PEACH EXPERIMENTS AT VINELAND.

The season of 1911 has been a very successful one in the experiment orchard at Vineland. Although some varieties such as Mountain Rose, Early Crawford, Reeve's Favorite and Fox Seedling failed to produce a crop, yet this was of much interest and value from an investigational standpoint.

The crop in the orchard in general was a very good one, and especially so when compared to the yields in other orchards in the same locality. The yield of Elbertas in many orchards was very light, but upon most of the fertilizer plots in the experiment orchard it was good and upon some plots a full crop.

Greensboro, Waddell, Carman, Alton, Gov. Hogg, Mamie Ross, Hiley, Ray, Belle of Georgia, Illinois, Capt. Ede, Bilyeu and Elberta were the varieties which produced good crops, while Mountain Rose, Early Crawford, Reeve's Favorite, Fitzgerald, Fox Seedling, Stevens, Stump, Edgemont Beauty and Moore's Favorite produced but a few fruits.

The early season was backward and about two weeks behind that of 1910 for a considerable period. Very little moisture fell during the months of May, June and July, and the effect of the drouth reached a critical point by the middle of August. If a heavy rain had not come at that time the crop of Elbertas would have been greatly reduced. Greensboro, ripening July 24th to 28th, found sufficient moisture for its needs, but beginning with Waddell, which ripened August 4th, all the varieties were severely affected by the drought until August 25th and 26th, when a heavy rain supplied moisture just in time to fill out the fruits upon the Elbertas.

The fruits of Hiley, Ray and Belle of Georgia were so small as to be considered almost second grade, due entirely to the drought. During the very dry, hot period in August some of the fruits (principally Elbertas) were sunburned upon one side, which later caused these fruits to crack when they expanded and developed at the ripening period.

The unusually dry season had a marked effect upon the pubescence upon the skin of the fruit at Vineland; all varieties being exceptionally "fuzzy." The flavor and quality of the fruit was very high, however, as is commonly the case in dry seasons. The Elberta fruits were exceptionally free at the pit and there were very few instances of any split pits in any of the varieties. Greensboro is often considerably affected in this way, especially in seasons of abundant moisture.

All varieties developed a good set of fruit buds by the close of the season and promise well for 1912.

WINTER KILLING OF PEACH BUDS.

At the beginning of the blossoming period of the peach the past season, many fruit growers observed for the first time that many of the fruit buds were killed. As several cool, frosty nights occurred in most parts of the State at that time, many attributed the injury to the frost. As a matter of fact, however, most of the injury occurred during the winter and previous to the blooming period, although a slight amount of frost injury occurred in some localities.

Although the peach is one of the most tender of our deciduous fruits, yet it is able to withstand quite severe temperatures just previous to blooming. Even when the buds show considerable pink color and are just ready to burst into bloom, they can successfully withstand a temperature as low as 24°. The first blooms appeared April 19th upon the varieties Elberta, Altou and Bilyen in the experiment orchard at Vineland.

During the winter the writer observed that a percentage of the fruit buds upon some varieties were failing. Upon April 12th, just previous to the time of blooming, a careful examination of trees of various varieties was made and the percentage of live buds was determined by actual count. The following table gives the results of the examination.

PERCENTAGES OF LIVE FRUIT BUDS ON VARIOUS VARIETIES OF PEACHES, VINELAND ORCHARD, APRIL 12TH, 1911.

HARDY.	Percent. of Live Buds.	HALF HARDY.	Percent. of Live Buds.	TENDER.	Percent. of Live Buds.
Greensboro	93.3	Elberta	72.9	Arp Beauty.........	61.0
Early Wheeler....	92.7	Frances	74.5	Mountain Rose......	53.4
Waddell	89.0	Wonderful	71.5	Early Crawford.....	59.0
Carman	97.0			Connecticut	53.4
Gov. Hogg........	97.5			Reeve's Favorite....	31.7
Alton	89.3			Fitzgerald	54.3
Hiley	95.0			Stump	55.6
Ray	93.0			Steven's Rareripe...	57.0
Belle of Georgia..	92.4			Fox Seedling........	48.0
				Edgemont	56.4
				Late Elberta........	59.0
Average.......	93.2	Average.......	72.9	Average.........	55.3

Varieties such as Greensboro, Carman, Gov. Hogg, Hiley and others of the Chinese Cling type, showed more than 90 per cent. of live buds and can be considered as passing the winter with almost no injury as from 5 to 10 per cent. of buds are likely to be weak or imperfectly formed in any season.

In contrast to these varieties just noted, Early Crawford, Mountain Rose, Reeve's Favorite, Fox Seedling, Stump and Steven's Rareripe showed less than 60 per cent. of live fruit buds upon April 12th, and form a group which showed themselves much less hardy under the conditions of 1910-1911.

The examination of the buds upon trees of the variety Elberta was extensive, and an average showed 72.9 per cent. of live buds. The varieties Frances and Wonderful showed 74.5 and 71.5 per cent., respectively, of live buds and can be classed with Elberta.

Experienced fruit growers are generally satisfied if one-half the fruit buds pass through the winter and spring months uninjured, and it might appear from the previous table that even the varieties with a little less than 60 per cent. of live buds should have produced a good crop. However, the notes to determine the percentages of live buds were taken April 12th, just before blooming, and some buds which were alive at that time were very weak and did not even set fruit, and all of the varieties of the Persian group type, under test at Vineland, produced very light crops. The average yields per tree of several of the more common varieties being as follows: Mountain Rose, 9 lbs. 4 oz.; Reeve's Favorite, 3 lbs. 8 oz.; Fox Seedling, 8 lbs. 4 oz.; Early Crawford, 6 lbs., and Steven's an occasional fruit.

In comparison to these yields, Greensboro with an average of 92 lbs. 14 oz.; Waddell, with 78 lbs. 9 oz.; Carman with 95 lbs. 8 oz., and Hiley with 91 lbs. 5 oz., show a much superior ability to withstand unfavorable conditions and produce fruit. Elberta and Frances, which showed 72.9 and 74.5 per cent. of live buds, respectively, upon April 12th, produced an average yield of 52 lbs. 7 oz. per tree in the case of Elberta and 73 lbs. per tree in the case of Frances.

It is a common belief among peach growers, especially in some districts, that a late growth of the trees is usually responsible for immaturity or a lack of hardiness in the fruit buds, with resultant injury during the winter. But although this is sometimes the cause of lack of hardiness, the experience of the past season indicates that trees of certain varieties that are stopped in their growth and development by severe drouth in summer, may suffer severely from winter injury to their fruit buds.

Upon the sandy soils of Central and Southern New Jersey there is very little danger of the trees making too late a growth even when cultivation is continued until September first, and it is recommended that peach growers cultivate their orchards frequently and thoroughly during the growing season, giving especial attention to the matter when the orchard is producing a heavy crop of fruit during a dry season.

SPRAYING TO CONTROL THE SCALE, PEACH SCAB AND BROWN ROT.

The trees upon all the fertilizer plots are sprayed thoroughly and uniformly each year to obtain the best possible results. Some of the trees in the variety tests are frequently used, however, for various spraying tests, and the mixtures used are not always beneficial. Some of the details of the general spraying work are of value from the standpoint of amount of material required, the time of application and the results secured.

The trees in these experiments were sprayed for scale and leaf curl March 20-22d with home-made, concentrated lime-sulfur diluted to have a specific gravity of 1.03 when applied as a spray.

A hand-pump mounted in a 100 gallon tank with two 25-foot lines of hose, two spray rods and two Simplex nozzles upon each line of hose was the outfit used in applying the spray. The spraying gang consisted of one man to pump and drive, and two men to spray.

One hundred gallons of material was sufficient for from 66 to 86 trees in Orchard No. 1, according to the size of the trees; the average for the whole orchard being about 71 trees.

The trees in Orchard No. 1 were four years old the past spring, and have been cut back annually one-third to one-half of their previous season's growth, so that they are not as large and spreading as trees of the same age which have not been pruned in this manner.

The time required to apply 100 gallons of spray with the particular outfit used was about one hour, and the total time required to spray 575 trees, including the refilling of the tank, was 14 hours.

The trees in Orchard No. 2 were three years old when sprayed for scale and leaf curl in the spring of 1911, and had been pruned in a similar manner to the trees in Orchard No. 1. The amount of spray required was 300 gallons for 534 trees, and the total time required to apply the spray was five hours.

Forty-eight trees were left without spraying in Orchard No. 1, and some leaf curl developed later, although not to a serious extent. However, peach growers in the southern part of the State should insure their trees against a possible attack of leaf curl, by using an effective lime and sulfur spray for the control of the scale.

SUMMER SPRAYING FOR THE CONTROL OF PEACH SCAB, BROWN ROT AND THE PLUM CURCULIO.

With the exception of a few trees reserved for special treatment, all the trees in the experiments at Vineland were systematically sprayed for the control of peach scab, brown rot and the plum curculio.

The orchard was first sprayed for the control of the curculio on May 8-9th, immediately after the petals had fallen, with two pounds of arsenate of lead (paste) to each fifty gallons of water. The same outfit was used for applying the arsenate of lead as was employed for the application of the lime-sulfur. Four hundred and thirty-six gallons were required for 660 trees in Orchard No. 1, and the total time required to apply the spray was about seven hours.

The next spraying was a combination of self-boiled lime-sulfur and arsenate of lead applied May 18-20th, just as the shucks or calyxes were being shed from the fruits.

A third spraying, consisting of self-boiled lime-sulfur only, was made June 8th and 9th, and a fourth application, consisting of the same material, July 6th and 7th.

Five hundred gallons of spray were required for trees in Orchard No. 1 for the second and third sprayings, and 450 gallons for the fourth spraying.

It will be noted that considerably less material is required to thoroughly spray the trees with self-boiled lime-sulfur when the foliage is present than to thoroughly spray the trees for the scale in the dormant season.

COST OF SPRAYING IN ORCHARD NO. 1.

The actual cost of the various applications of spray mixture during the season is of interest from a practical standpoint. The labor upon all the spraying work in the orchard during the season is figured at $2 per day of 9 hours, and the expense of one horse and a boy or man to drive at $2.50 per day. The two men who actually applied the spray to the trees were connected with the Experiment Station and were familiar with spraying work, so that a charge of $2 per 9-hour day is considered a fair rate of expense.

The cost of lime is figured at one cent per pound and sulfur at three cents per pound. These charges are rather high, but are only slightly excessive when freight and cost of hauling the material is considered in connection with some waste of the lime.

Eight hundred gallons of lime-sulfur solution were required to spray 610 trees in Orchard No. 1 for the scale, and the labor and time required was three men and one horse for 14 hours. The total expense including the cost of the lime and the sulfur was $16.16.

The application of arsenate of lead to about 660 trees in Orchard No. 1, May 8th and 9th, for the control of the plum curculio, was at an expense of $7.21, and is given in detail below:

18 lbs. arsenate of lead, at 12 cents	$2 16
Labor of 2 men for 7 hours	3 11
Labor of 1 man and horse for 7 hours	1 94
Total	$7 21

The first spraying of self-boiled lime-sulfur, which also contained arsenate of lead, was applied to about 635 trees, at an expense of $11.38, as follows:

80 lbs. lime	$0 80
80 " sulfur	2 40
20 " arsenate of lead	2 40
Labor 2 men for 8 hours	3 56
Labor 1 horse and man 8 hours	2 22
Total	$11 38

The second spraying of the self-boiled lime-sulfur, applied without the addition of arsenate of lead on June 8th and 9th, was at an expense of $8.61 for about 635 trees, as follows:

80 lbs. lime	$0 80
80 " sulfur	2 40
Labor 2 men for 7½ hours	3 33
Labor 1 man and horse 7½ hours	2 08
Total	$8 61

The third spraying of self-boiled lime-sulfur was applied July 6th and 7th, at a cost of $8.60:

72 lbs. lime	$0 72
72 " sulfur	2 10
Labor 2 men for 8 hours	3 56
Labor 1 horse and man for 8 hours	2 22
Total	$8 60

The total cost of the three sprayings of self-boiled lime-sulfur in Orchard No. 1 was at the rate of $4.50 per 100 trees. This also included the cost of the arsenate of lead in connection with the first spraying of self-boiled lime-sulfur. The cost of the application of the home-made concentrated lime-sulfur for the scale was at the rate of $2.65 per 100 trees, and that of the application of arsenate of lead alone on May 8th and 9th was at the rate of $1.09 per hundred trees, making a total expense for spraying for the entire season of $8.24 per 100 trees. This expense also includes all labor in preparation of the sprays for application.

COST OF SPRAYING IN ORCHARD NO. 2.

The trees in Orchard No. 2 are one year younger than in Orchard No. 1, as previously stated, and required less spray material, and the cost of spraying 534 trees with lime-sulfur was about $6.11.

Two hundred and twenty-five gallons of spray were required for an application of arsenate of lead upon May 9th, and the time of application was 3½ hours, making an expense of $3.61.

The first application of self-boiled lime-sulfur, which also contained arsenate of lead, required 200 gallons of material and was applied on May 20th, in 4½ hours, at an expense of $5.49.

A second spraying of self-boiled lime-sulfur, to which no arsenate of lead was added, was applied June 9th, in 4½ hours. Two hundred and ten gallons of spray were required and the expense was $4.61.

A third spraying of self-boiled lime-sulfur upon July 7th required 200 gallons of spray, which was applied in 4 hours at an expense of $4.17.

The amount of material and the time required for application is practically the same in each case where a similar material was applied, which indicates consistent work on the part of the men who applied the spray.

The total cost of the season's spraying in Orchard No. 2, including one application of lime-sulfur for scale and leaf curl, one application of arsenate of lead, one application of self-boiled lime-sulfur and arsenate of lead and two applications of self-boiled lime-sulfur was $4.49 per 100 trees.

COLD STORAGE TEST WITH PEACHES.

During the early summer the Training School at Vineland offered the use of their cold storage in a co-operative test of preserving the different varieties of peaches, as they ripened, for an exhibit the last week in September.

Beginning with Greensboro, which ripened July 24th, and including such varieties as Waddell, Carman, Alton, Gov. Hogg, Mountain Rose, Elberta and others, sample fruits were placed in crates and taken to the storage as they ripened.

A thermograph was placed in the storage with the peaches to keep a constant record of the temperatures. An attempt was made to keep the storage at as low a temperature as possible without freezing the fruit. The thermograph records show that the temperature varied from 28 to 32 degrees from 12 o'clock midnight to 12 o'clock noon each day. From about 11 to 12 o'clock midnight the temperature reached 32 degrees, and from about 11 to 12 o'clock noon it reached 28 degrees. This was very constant for each day.

All of the fruit was left undisturbed in the storage until September 23d, when it was transported to Trenton by auto truck for exhibition at the Inter-State Fair.

All varieties had kept exceedingly well and were placed upon the exhibition table.

The temperature upon September 25th and 26th was very high for the season of the year, and was a severe test upon cold storage fruit, yet the early varieties of peaches held up well until the latter part of the week when they commenced to decay.

Several crates of Elbertas were placed in the storage at Vineland each day from August 24th to 29th, and these were placed upon the exhibition table at the Inter-State Fair in perfect condition September 25th, and remained in good condition until the close of the fair upon the 29th. Practically all other exhibits of peaches which had been held in cold storage were decayed by that date.

The success of this cold storage test at Vineland was due to thorough spraying of the fruit which prevented the attacks of scab and brown rot; the careful handling of the fruit from tree to storage; the maintenance of a constant low temperature, and careful handling again from storage to exhibition table. All of these factors must be well managed for the best results in cold storage of peaches.

PEACH YELLOWS AND LITTLE PEACH.

All the trees in the experiment orchard are under close observation for the appearance of yellows and little peach, and any tree showing symptoms of either disease is pulled out and removed from the orchard.

Five trees have been removed from Orchard No. 1 during the past season, and another tree has been noted as showing suspicious symptoms. The following is the record of trees diseased:

Row 26—Tree 23, Belle of Georgia, yellows.
" 27— " 23, Stump, yellows.
" 4— " 1, Greensboro, yellows.
" 4— " 2, Elberta, yellows.
" 5— " 13, Greensboro, yellows.

The Belle of Georgia and Stump trees which became diseased were on the southeast corner of the orchard, and near an adjoining orchard. The Elberta tree and one of the Greensboro trees were located near the roadway at the west and were really near the outside of the orchard as were the Stump and Elberta trees. One Greensboro tree is the only case in Orchard No. 1, located more than two rows of trees from the outside of the orchard.

No cases of little peach disease appeared in Orchard No. 1 during the season of 1911, and the loss of 5 trees out of a total of 675 is not considered serious, although this is a gain of one diseased tree over 1910.

No diseased trees were detected in Orchard No. 2 during 1910, but 5 cases have appeared in 1911 with two trees under suspicion. The details are as follows:

Three Elberta trees in Plot B, little peach.
One Late Elberta, Row 27, Tree 10, yellows.
One Smock, Row F, Tree Q, little peach (suspected).
One Elberta, Plot 22, little peach.
One Hiley in west row (suspected).

The Elberta trees upon Plot B showed no indication of disease until midsummer when advanced symptoms of little peach appeared. These trees all adjoin one another upon the plot, and are near the edge of the orchard and have received no fertilizer since the trees were planted.

The Late Elberta tree affected with yellows has never made a very vigorous growth, and is also located in an outside row.

The Smock tree which is suspected of being affected by little peach is another tree located in an outside row. The Elberta tree on Plot 22 is the only case that is located several rows from the outside of the orchard.

The writer has observed that weak or neglected trees are apparently more susceptible to yellows and little peach than trees of normal vigor, and yet trees which are very heavily fertilized often become diseased very quickly also. It appears rather peculiar that nearly all of the diseased trees have been in rows near the edge of the orchard. Some of the trees were not especially vigorous, but others were as large as any of the other trees of the same varieties under similar conditions.

These two diseases still offer an interesting problem to investigators.

Diseased trees which were removed in 1910 were replaced by others in the spring of 1911, and all have made a good growth during the past year.

FERTILIZER EXPERIMENTS WITH APPLES.

In the spring of 1896 a fertilizer experiment with apples was started at the College Farm. The experiment is composed of three plots, each containing two trees of the following varieties: Smith Cider, Baldwin, King, Jonathan, Oldenburg and Gravenstein.

The annual fertilizer treatment of the various plots is as follows:

Plot 1.—To receive no fertilizer,

Plot 2.—To receive 500 lbs. per acre of an even mixture of ground bone, acid phosphate and muriate of potash.

Plot 3.—To receive the same treatment as Plot 2, with 150 lbs. per acre of nitrate of soda additional when the trees came into bearing.

In tree fruit experiments more than two trees of a variety should compose the various plots or treatments. There is often a marked difference in the behavior of individual trees under similar treatment, and where there are only two of a variety one may be injured in some manner and seriously affect the experiment.

Although the number of plots is limited and the number of trees of each variety too few for an ideal comparison, yet it is believed that the results of this experiment are of much value, especially to orchardists located on soils of a similar type.

The soil upon which this orchard is located is a strong, well drained loam, containing some clay. The subsoil is somewhat gravelly and affords good drainage. The orchard does not suffer from lack of moisture except in unusually dry seasons like those of 1910 and 1911.

From the time of planting until 1905, garden vegetables were grown upon Plots 2 and 3, although no additional fertilizers were added. Plot 1 was kept cultivated, but was not cropped.

In the fall of 1900, three trees were replaced as follows: One Baldwin tree and one Gravenstein on Plot 1, and one Jonathan tree on Plot 3.

In 1902, one Jonathan tree on Plot 1 was ruined by an ice-storm and was replaced. These replantings affect the records, and will be considered later.

APPLE EXPERIMENT.

The first fruits were produced in 1901, the varieties Smith Cider, Jonathan and Oldenburg bearing from one to several fruits. One Baldwin tree on Plot 1 and one King tree on Plot 3 also bore three and one fruits, respectively. In 1902 a little more fruit was produced principally by the variety Smith Cider. Gravenstein did not produce any fruit until 1905, and then only a very small amount.

Nitrate of soda was applied to Plot 3 for the first time in 1904, and comparisons with Plots 1 and 2, to determine the effect of the nitrate, must be made upon subsequent yields.

The yields from 1901 to 1904, inclusive, are recorded in the following table:

TABLE NO. 1.—YIELDS OF FRUIT IN APPLE EXPERIMENT FROM 1901 TO 1904 (INCLUSIVE).

VARIETY.	PLOT 1.				PLOT 2.				PLOT 3.			
	Tree 1.		Tree 2.		Tree 1.		Tree 2.		Tree 1.		Tree 2.	
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Smith Cider............	122	5	45	14	87	10	55	8	3	13	31	11
Baldwin	0	0	90	11½	37	1	27	9	14	10	0	6
King	5	7	4	10	7	11	5	8	11	8	0	8
Jonathan	0	6	87	9	87	13	103	2	0	0	77	5
Oldenburg	7	4	7	3	21	14	30	11	10	0	16	1
Gravenstein	0	0	0	0	0	0	0	0	0	0	0	0
Total per Plot......	371 lbs. 5½ oz.				464 lbs. 7 oz.				165 lbs. 14 oz.			

It will be noted that no yields appear for Baldwin tree No. 1, Plot 1, and Jonathan tree No. 1, Plot 3. Jonathan tree No. 1, Plot 1, produced 6 ounces of fruit in 1901. These trees were replanted as previously noted and directly affect the yields of the plots. On the basis of actual yield Plot 2 has produced the most fruit, but this is hardly a fair basis of comparison for Plots 1 and 3, because of the above mentioned facts. It was thus considered best to average the yields of the various varieties upon each plot in computing the plot yield, and where a tree was replanted the yield of the other tree of the same variety upon the same plot has been taken as the average. For example, Jonathan tree No. 1, Plot 1, was replaced and shows no yield, but Jonathan tree No. 2 shows a yield of 87 lbs. 9 ozs., and this has been taken as the average yield of Jonathan for that plot.

The following table shows the yields of the various plots from 1901 to 1904, computed on the basis just explained:

TABLE No. 2.—YIELDS OF FRUIT IN APPLE EXPERIMENT FROM 1901 TO 1904 (INCLUSIVE), ON BASIS OF AVERAGE PER TREE OF EACH VARIETY.

VARIETY.	Plot 1.		Plot 2.		Plot 3.	
	lbs.	oz.	lbs.	oz.	lbs.	oz.
Smith Cider................	84	1½	71	9	17	12
Baldwin	90	11½	32	5	7	8
King	5	½	6	9½	6	0
Jonathan	87	13	95	7½	77	5
Oldenburg	7	3½	26	4½	13	½
Gravenstein	0	0	0	0	0	0
Average total per Plot....	274	14	232	3½	121	9½

An examination of the above yield shows that the trees in Plot 1 which have received no fertilizer have thus far produced the highest average total yield, although this is not true in all cases when individual varieties are considered as the varieties King, Jonathan and Oldenburg have produced best upon Plot 2. Plot 1 in average total also appears better than Plot 2 in the above table, because of the somewhat unusual yield of Baldwin tree No. 2 in Plot 1. As Baldwin tree No. 1, of that plot, was replanted and is not bearing, tree No. 2 represents the average for the plot, and its yield of 90 lbs. 11 oz. is in excess of the combined yields of all the other Baldwin trees. However, we will give Plot 1 all the credit possible at this time and consider it as being at least equal to Plot 2, and much better than Plot 3 up to the season of 1905. Plot 3 should compare quite closely with Plot 2 at this time, but falls much below it in average total yield and upon the basis of individual varieties.

The year 1905 showed a very decided increase in the yield of all varieties which was not exceeded in either 1906 or 1907.

From about 1903 to 1908 the yields appear quite variable when compared by seasons, and rather small in some instances. This was a period, however, when the San José scale made its appearance in orchards and various mixtures were experimented with. The Bordeaux mixture also came in for some investigation, and the general crop of fruit in the orchard was affected in some seasons.

The yields for the years 1905 to 1908, inclusive, have already been published in the annual reports of the station.

At the beginning of the season of 1909 the trees on the various plots were sprayed with a standard Bordeaux mixture and arsenate of lead just after the petals had fallen from the blooms, with the exception of trees No. 1 of the various varieties upon Plot 2. These should have been sprayed with Bordeaux also, but were sprayed with Pyrox instead. Wet weather followed the application of the spray and the Bordeaux burned and russeted the fruit severely; so much so, in fact, as to decidedly affect the yield. It was not believed at the time that the yield of a few trees sprayed with Pyrox would differ to any extent from those receiving Bordeaux and arsenate of lead, but such was the case.

The average yield per tree in 1909 for the various varieties upon Plot 2 has been computed upon the basis of the yields of trees No. 2 upon that plot, which were sprayed with Bordeaux and arsenate of lead similar to the other trees.

The annual yields for the years 1909, 1910 and 1911 appear in the three tables following. Beginning with the year 1910, the fruit upon the trees was uniformly thinned where the set was too heavy for the production of fair sized specimens:

TABLE No. 3.—YIELDS OF APPLES UPON FERTILIZER PLOTS DURING SEASON OF 1909.

VARIETY.	PLOT 1.				PLOT 2.				PLOT 3.			
	Tree 1.		Tree 2.		Tree 1.		Tree 2.		Tree 1.		Tree 2.	
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Smith Cider............	93	0	81	14	362	6	97	14	144	0	142	2
Baldwin	0	0	366	9	158	5	148	14	235	8	97	5
King	7	8	22	5	135	4	40	8	24	10	21	8
Jonathan	0	0	73	8	566	10	418	14	231	14	185	12
Oldenburg	29	10	5	14	95	14	8	8	12	2	3	10
Gravenstein	0	0	4	10	58	15	0	0	0	0	29	5
Total per Plot......	684 lbs. 14 oz.				2,092 lbs.				1,127 lbs. 12 oz.			

In the above table of yields for 1909 it will be noted that Baldwin tree No. 2, Plot 1, again produced a very large yield in comparison with the other Baldwin trees, and that if the yield of this one tree was not considered, Plot 1 would have a very low yield, for as considered it falls far below Nos. 2 and 3 in point of yield. It will be noted further in the yields for 1911 (Table No. 5) that this tree again produced a very large yield in comparison to the other Baldwin trees. This is all the more remarkable, because this tree is upon the plot which has received no fertilizer since the experiment was started in 1896.

TABLE NO. 4.—YIELDS OF APPLES UPON FERTILIZER PLOTS DURING SEASON OF 1910.

VARIETY.	PLOT 1.				PLOT 2.				PLOT 3.			
	Tree 1.		Tree 2.		Tree 1.		Tree 2.		Tree 1.		Tree 2.	
	Weight. lbs.	oz.	Weight. lbs.	oz.	Weight. lbs.	oz.	Weight. lbs.	oz.	Weight. lbs.	oz.	Weight. lbs.	oz.
Smith Cider............	373	8	483	3	436	4	247	10	568	6	404	12
Baldwin	*..	..	41	3	288	..	...	..	678	12	169	8
King	133	14	294	2	574	13	284	2	545	..	442	4
Jonathan	*8	8	461	1	359	..	509	10	*208	14	410	8
Oldenburg	48	..	84	5	342	1	342	10	201	10	311	15
Gravenstein	..	..	30	15	290	6	68	2	102	..	168	2
Total per Plot......	1,958 lbs. 11 oz.				3,742 lbs. 10 oz.				4,211 lbs. 11 oz.			

* Reset.

TABLE NO. 5.—YIELDS OF APPLES UPON FERTILIZER PLOTS DURING SEASON OF 1911.

VARIETY.	PLOT 1.				PLOT 2.				PLOT 3.			
	Tree 1.		Tree 2.		Tree 1.		Tree 2.		Tree 1.		Tree 2.	
	Weight. lbs.	oz.	Weight. lbs.	oz.	Weight. lbs.	oz.	Weight. lbs.	oz.	Weight. lbs.	oz.	Weight. lbs.	oz.
Smith Cider............	716	4	901	4	1,062	2	729	..	554	10	840	12
Baldwin	124	12	1,432	13	535	14	655	..	926	8	895	6
King	416	6	553	12	318	2	374	8	276	6	476	4
Jonathan	111	14	768	14	730	5	894	7	347	15	582	14
Oldenburg	160	11	173	4	140	..	373	8	419	4	117	..
Gravenstein	542	..	269	..	426	..	352	14	392	14	663	12
Total per Plot......	6,170 lbs. 14 oz.				6,591 lbs. 12 oz.				6,493 lbs. 9 oz.			

A study of the yields of fruit upon Plot 3 show that a distinct gain has been made in comparison with the other plots since 1905, and that this plot had a greater total yield than Plot 2 in 1910. The yields in 1911 indicate an "apple year" and all trees produced well.

When actual yields are considered and no credit is given to any plot for replaced trees, Plot 2 is much better than Plot 1. It is well to grant the unfertilized plot all the credit that can fairly be given to it, however, and make comparisons with this point in mind.

The average total yields of the various varieties upon each plot from 1905 to 1911, inclusive, is given in the following table:

TABLE NO. 6.—AVERAGE TOTAL YIELDS OF FRUIT IN APPLE EXPERIMENTS, 1905–1911 (INCLUSIVE).

VARIETY.	Plot 1.		Plot 2.		Plot 3.	
	lbs.	oz.	lbs.	oz.	lbs.	oz.
Smith Cider	1,772	1	2,356	10½	1,981	7½
Baldwin	2,325	6	1,029	4½	1,731	12½
King	800	8	1,165	0	1,049	10½
Jonathan	1,813	5	2.445	10	1,710	5
Oldenburg	340	8	1.029	13½	773	15
Gravenstein	324	12	651	4	718	14

NOTE.—Trees No. 1 of Baldwin, Jonathan and Smith Cider upon Plot 1, and Tree No. 1 Jonathan upon Plot 3, have not been considered in these averages.

An examination of the yields in the preceding table shows Plot 2 as considerably better than Plot 1, and this comparison is upon a basis most favorable to Plot 1. The latter plot has had three trees replanted at different times, and the average yield for those varieties is based upon the yield of the remaining tree in each case. This should favor Plot 1 to some extent, especially in the case of Baldwin tree No. 2, of Plot 1, which has an individual yield since 1904 of 2,274 lbs. ½ oz., and as it is the only Baldwin tree in full bearing on the plot, its yield has been taken as the average for that plot in the preceding tables. The Baldwin variety has behaved differently from all the other varieties in this experiment; the yield on Plot 2 being the lowest of any plot, while all other varieties are best on Plot 2, with the exception of Gravestein, which has produced the most fruit upon Plot 3.

The Baldwin trees upon Plot 2 are not nearly as large as those upon Plot 3, and Baldwin tree No. 2, Plot 1, is the largest of all the Baldwin trees in these experiments. It is possible that the Baldwin is not favored by additional amounts of potash and phosphoric acid applied to the particular soil type under test.

The addition of nitrate of soda to Plot 3 had undoubtedly benefited the rating of this plot, as previous to 1905 Plot 2 had produced double the amount of fruit in comparison. Plot 3 is also at a disadvantage to some extent from being partially shaded by a hedgerow about 40 feet distant from the outside row of trees. But allowing all that is possibly fair to this plot up to the present time, the nitrate of soda in addition to the other fertilizers has not increased in yield above Plot 2 except with the varieties Baldwin and Gravenstein. The effect of the nitrate of soda has been apparent in the leaf and twig growth of the trees upon this plot, and as the trees become older it will probably result in further gains in yield. An analysis of the dormant twigs from the trees upon the various plots shows the most nitrogen stored up by the trees upon Plot 3.

It will be of interest and value to now make a comparison of the plots upon the basis of actual total yield since 1904, when nitrate of soda was first applied to Plot 3.

TABLE NO. 7.—YIELD OF INDIVIDUAL TREES IN APPLE EXPERIMENT 1905–1911 (INCLUSIVE).†

VARIETY.	PLOT 1.				PLOT 2.				PLOT 3.			
	Tree 1.		Tree 2.		Tree 1.		Tree 2.		Tree 1.		Tree 2.	
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Smith Cider	1,625	11	1,758	9	2,560	2	1,691	1	1,807	5	1,872	5
Baldwin	*124	12	1,958	15	971	7	787	15	1,800	7	1,330	5
King	646	14	924	5	1,197	7	936	14	1,084	1	949	2
Jonathan	*120	12	1,739	13	1,726	2	2,184	4	*581	8	1,501	8
Oldenburg	259	10	431	14	855	7	1,147	10	866	9	667	8
Gravenstein	*54	2	320	2	763	12	421	..	508	14	867	4
	2,831	13	7,133	10	8,074	5	7,168	12	6,648	12	7,188	0
Total Yield per Plot	9,965 lbs. 7 oz.				15,243 lbs. 1 oz.				13,836 lbs. 12 oz.			

* Trees which have been replanted and are not in full bearing.

† 1909 yield of fruit not included in this total.

The yields in Table No. 7 are the actual yields per tree upon the various plots since 1905, with the yields for the season of 1909 omitted. It will be noted again that the replanted trees upon Plot 1 greatly reduce the yield on that plot. This is also true to a less extent of Jonathan tree No. 1, on Plot 3. This table explains why comparisons in the previous tables have been made on the basis of averages for the various varieties under test, and making the average for the variety per plot on the basis of one tree where the other tree of the same variety was replanted. The general result of the experiment is the same in either case, however, and differs only in degree according to the basis of comparison.

The quality of the fruit has been about the same upon all the plots. In general, it has averaged somewhat larger upon Plot 3, which has received the nitrate of soda in addition to ground bone, acid phosphate and muriate of potash. There has been very little difference in the time of ripening of the fruit under the various treatments, but in some cases it has been slightly later upon Plot 3.

As a summary of the results thus far obtained, it can be stated that the applications of phosphoric acid and potash in the form of ground bone, acid phosphate and muriate of potash, have greatly increased the yields of apples of all varieties tested except Baldwin. The application of nitrate of soda in addition to the other elements caused a more vigorous growth of twigs and foliage, but had little effect upon the yield of fruit for several seasons. The trees upon Plot 3, however, have made distinct gains in yield in comparison to the other plots in recent years and are likely to continue to do so as the trees become older.

WEATHER OBSERVATIONS.

The year ending October 31st, 1911, has been a notable one because of extremes of weather conditions. The total precipitation for the year of 55.39 inches exceeds the normal for this section by 6.63 inches, but was very unevenly distributed and resulted in severe injury to plants throughout the State.

The total rainfall from July 26th to August 25th was only 0.90 inches, yet the total for the week of August 25th was 11.78 inches. The precipitation for that week far exceeds the rainfall for any other week since records have been kept at the College Farm, and is in excess of the total rainfall for any one month excepting August, 1904, and July, 1897.

The month of May was unusually dry with a total precipitation of 1.55 inches. Weather conditions were especially favorable from April 29th to May 8th for the blooming of fruit trees, and a good set of fruit resulted, especially of apples. The maximum mean during this period was 60°, and the minimum mean 50°.

The last killing frost in the spring of 1911 occurred upon April 12th, with a minimum temperature of 29°. The first killing frost in the fall occurred upon October 29th, with a minimum temperature of 28°. The past winter was comparatively mild, and the lowest minimum was 1° on December 10th.

Some extended and exceptionally hot weather occurred during the first part of July; the highest maximum for the year being reached on July 3d, with a temperature of 102°.

Tables showing the daily and monthly precipitation in inches and the monthly maximum and minimum means of temperature are given upon succeeding pages.

DAILY AND MONTHLY PRECIPITATION, IN INCHES, AT COLLEGE FARM FOR THE YEAR ENDING OCTOBER 31ST, 1911.

DATE.	Nov. 1910	Dec. 1910	Jan. 1911	Feb. 1911	Mar. 1911	April 1911	May 1911	June 1911	July 1911	Aug. 1911	Sept. 1911	Oct. 1911
1			0.11				0.17	0.17			0.16	0.05
2	T		0.75	0.30			0.01	0.15				0.20
3	1.90		1.00	T				0.04	T		T	
4	0.90		0.21	1.95	0.15	0.54						T
5	0.09	0.08				1.35		0.66				
6		0.45		0.06	0.30	0.04		0.20			0.10	
7		0.08		0.10		T		0.17				0.85
8	0.02			T			0.11	0.04			T	
9			0.05	0.02		0.45					T	
10				0.06	0.24				0.02		0.02	
11	0.02	0.28	0.05					0.32			0.49	0.30
12		T	0.04		T		0.09	1.30	0.03	0.13	T	
13	T		0.30					0.41				
14	T		0.07	T	T	0.33		0.38	1.84			
15	T		0.10	0.30	0.95	0.10		T	0.75	0.22	0.25	0.17
16		0.06			0.30	T	T	0.08		0.13	0.20	
17				0.12		T	0.02		0.75			
18	0.11			0.12				0.17		0.42		0.11
19		0.20			0.15	0.04	0.29					0.40
20		T		0.40	0.27	1.42	0.06	0.04	T			0.16
21				T			0.01		0.50			0.40
22			0.29	T		0.19		T	0.78		0.25	0.07
23		T		T		T		0.05		T	0.01	0.93
24		1.17		T			0.04	0.55	0.51		0.02	
25	0.15							0.06	0.16	1.70		
26			T					0.30		0.40	T	
27			0.19		0.51			T		2.11	0.01	
28	0.03	T	0.09		0.40					0.05		
29	0.60	0.03	0.10		0.14					0.02		
30	0.04	0.15	0.17		0.45	0.08			T	0.80	0.77	
31					T		0.75			6.70		
Total....	3.86	2.50	3.52	3.43	3.86	4.54	1.55	5.19	5.34	12.68	2.28	6.64
Normal..	3.30	3.74	3.28	3.61	4.08	3.45	3.72	3.33	6.42	5.75	3.97	4.11

MONTHLY PRECIPITATION, IN INCHES, SINCE JANUARY 1ST, 1896.

YEARS.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	Total Yearly.
1896	.....	.....	1.68	5.85	5.92	1.41	3.70	4.93	4.37	2.42	4.81	1.62	*36.71
1897	2.93	1.59	2.39	2.77	2.47	3.47	6.45	2.50	12.84	3.81	2.10	1.59	44.93
1898	4.52	5.09	3.92	3.49	3.09	4.17	7.86	1.13	3.91	6.44	1.46	5.80	50.88
1899	7.14	3.16	4.88	5.37	6.63	1.50	2.04	3.54	6.32	3.45	7.80	2.96	54.79
1900	4.11	2.06	4.35	5.30	3.40	2.38	5.58	2.64	6.94	2.24	3.30	3.53	45.83
1901	4.27	2.32	2.01	0.76	5.19	7.39	5.01	0.81	9.12	8.90	1.86	1.99	49.63
1902	2.21	7.30	2.70	6.46	3.79	3.09	1.51	6.08	3.42	6.29	5.25	7.76	55.86
1903	1.58	6.83	3.84	4.61	4.74	4.57	0.29	7.35	5.07	5.97	3.69	7.16	55.70
1904	1.21	3.53	3.11	2.52	2.38	3.49	2.79	2.50	7.99	13.01	5.09	5.80	53.42
1905	2.70	2.07	2.67	2.14	4.02	2.83	1.83	1.83	4.23	4.96	4.32	2.99	36.59
1906	2.28	3.39	3.04	2.04	4.28	4.38	4.75	3.20	6.10	3.95	1.93	3.02	42.36
1907	1.50	3.71	3.44	2.55	2.99	2.22	4.50	3.44	6.42	2.79	6.85	4.95	45.36
1908	5.48	1.88	1.87	3.30	1.94	3.31	7.23	2.34	5.12	5.00	1.93	3.67	43.07
1909	1.16	3.33	3.17	5.40	3.49	7.25	2.01	2.23	3.45	9.07	3.73	1.22	45.51
1910	1.89	5.47	6.65	2.58	1.73	5.01	2.86	4.94	0.28	6.26	3.49	3.86	45.02
1911	3.86	2.50	3.52	3.43	3.86	4.54	1.55	5.19	5.34	12.68	2.28	6.64	55.39
Average....	3.11	3.54	3.31	3.65	3.73	3.79	3.73	3.40	5.67	6.07	3.76	4.27	48.24
Normal for this section	3.30	3.74	3.28	3.61	4.08	3.45	3.72	3.33	6.42	5.75	3.97	4.11	48.76

* Ten months only.

MONTHLY MAXIMUM AND MINIMUM MEANS OF TEMPERATURE SINCE 1896.

YEAR.	November.		December.		January.		February.		March.		April.		May.		June.		July.		August.		September.		October.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1896	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	77.4	56.9	85.3	65.4	84.5	62.7	75.2	54.4	60.9	42.9
1897	58.5	39.0	40.9	21.4	37.2	21.6	39.6	24.6	48.8	31.9	.....	.....	71.7	50.8	77.6	55.5	84.3	65.6	82.5	58.7	78.4	54.2	68.1	44.7
1898	54.0	35.4	42.5	26.8	40.2	25.8	42.1	23.6	55.5	35.2	59.3	37.8	60.6	49.2	83.4	58.5	87.0	65.0	84.3	65.4	80.9	56.9	66.7	46.9
1899	52.2	33.5	40.0	25.3	39.0	20.5	33.4	17.2	47.2	30.8	62.3	37.5	75.2	48.7	84.4	60.5	85.8	64.0	81.6	63.1	75.5	53.7	66.7	47.4
1900	52.5	34.8	45.1	27.2	40.9	23.5	40.6	21.8	45.5	25.8	61.8	40.0	75.6	48.4	81.8	60.2	88.4	64.6	86.8	66.8	81.6	59.3	67.8	51.2
1901	55.9	38.9	41.7	24.4	37.6	24.0	32.2	17.6	48.6	30.6	56.1	40.5	69.4	48.9	83.5	58.3	87.4	67.7	84.6	64.9	78.7	56.4	67.0	42.2
1902	46.8	30.5	41.3	23.9	36.7	20.1	25.1	19.5	54.8	34.4	62.2	40.4	73.2	49.0	81.5	56.2	84.0	63.1	81.8	58.6	73.9	54.7	65.7	45.9
1903	58.9	39.1	38.6	22.7	37.4	21.6	42.5	23.5	58.7	37.4	61.2	39.8	76.9	49.9	72.9	55.2	85.4	61.2	77.8	59.0	76.2	54.1	65.1	46.5
1904	49.9	29.3	37.1	20.3	31.0	13.2	34.1	15.0	45.8	28.0	57.2	35.5	77.4	50.7	80.7	56.9	82.3	61.7	82.0	59.7	76.6	53.1	63.8	39.3
1905	49.1	39.7	34.4	17.2	34.7	18.6	32.2	12.9	57.3	29.2	69.7	38.6	72.7	49.7	78.3	57.3	85.6	63.7	80.0	60.9	72.7	52.7	66.0	48.6
1906	52.5	30.5	44.6	27.4	44.1	27.2	41.8	18.5	41.3	25.8	64.4	38.8	74.4	48.7	81.9	59.8	83.6	63.0	83.4	65.5	79.8	57.4	63.0	44.9
1907	52.1	35.0	41.4	23.0	39.8	21.5	32.4	11.4	51.5	29.3	56.4	32.9	66.5	44.6	75.7	52.6	84.6	61.5	81.7	58.7	76.9	56.6	61.7	37.6
1908	51.1	33.0	43.3	26.9	39.7	21.0	38.1	16.0	51.3	32.5	63.1	37.8	70.9	50.0	83.0	56.3	87.3	62.5	81.5	57.6	76.5	52.3	66.2	44.6
1909	52.0	27.3	41.8	15.6	40.5	19.2	46.0	27.9	47.9	28.7	61.5	39.0	71.6	49.1	81.2	59.9	84.9	59.4	81.6	59.5	75.1	54.5	61.8	39.3
1910	54.5	36.0	36.6	21.4	38.0	20.3	38.6	21.5	57.7	32.2	65.9	41.8	72.2	49.1	77.0	56.8	88.3	63.4	79.7	60.5	77.8	56.6	68.4	45.0
1911	47.8	31.6	34.4	17.3	41.0	24.2	38.0	22.0	48.9	27.1	58.9	36.9	78.2	65.4	79.2	59.6	88.2	76.5	82.3	61.5	76.0	57.3	63.2	44.7

REPORT OF THE POULTRY HUSBANDMAN.

REPORT OF THE POULTRY HUSBANDMAN.

HARRY R. LEWIS, B.S.

The work of the poultry department came under my supervision December 1st, 1910, at which time it was inaugurated as a department of the State Experiment Station. Until May 1st, 1911, little experimental work could be started owing to limited equipment. At this time, however, the appropriation of fifteen thousand, which was passed by the State Legislature became in part available, thus making possible extended experimental work along poultry lines.

During the winter of 1910 and 1911 experiments in artificial incubation were carried on to determine the actual amount of moisture necessary for best hatching. Experiments were also started covering various methods of feeding the baby chicks, most desirable brooder temperatures, the practicability of the New York State Gasoline Brooder, the advantages of early versus late hatching of leghorns, the advisability of making an early selection in young chicks from the standpoint of vigor, a study of sprouted oats as a source of succulent green food.

The results of the above are shown in the following pages.

The time since May 1st, 1911, has been spent in the planning and laying out of the new poultry plant and in the erection of the poultry buildings, most of which have been built by our own staff, thus enabling the keeping of a much more accurate record of labor and material as well as getting a larger equipment from the money appropriated.

The poultry husbandman has made trips to various sections of the State to get in touch with the distribution and magnitude of the industry, to deliver lectures on poultry topics and to advise in regard to the laying out and equipping of poultry plants. The following chart shows places visited during the year, and the accompanying key designates the character of work done:

Owing to an increasing demand from all over the State for some systematic educational work along general poultry lines, the department has outlined and introduced a reading course in poultry husbandry which is available to any organization in the State of more than ten members, such as granges, poultry associations, &c. In this connection it is urged that the poultrymen of each county organize county associations to receive the benefit of this educational work. The details of this work will be found in the chapters following.

The office correspondence, covering the various poultry problems has grown remarkably if we consider the fact that this line of effort has only been under way for one year. During the past twelve months letters have been received from over 600 residents of the State regarding poultry topics. These have been answered by direct correspondence, circulars and bulletins.

Four circulars were issued during the year, as follows:

No. 1. The New Jersey State Dry Mash and its Accompanying Rations.
No. 2. Food Material and the Compounding of Rations.
No. 3. Organization Circular for Educational Work.
No. 4. Rations for Poultry Feeding.

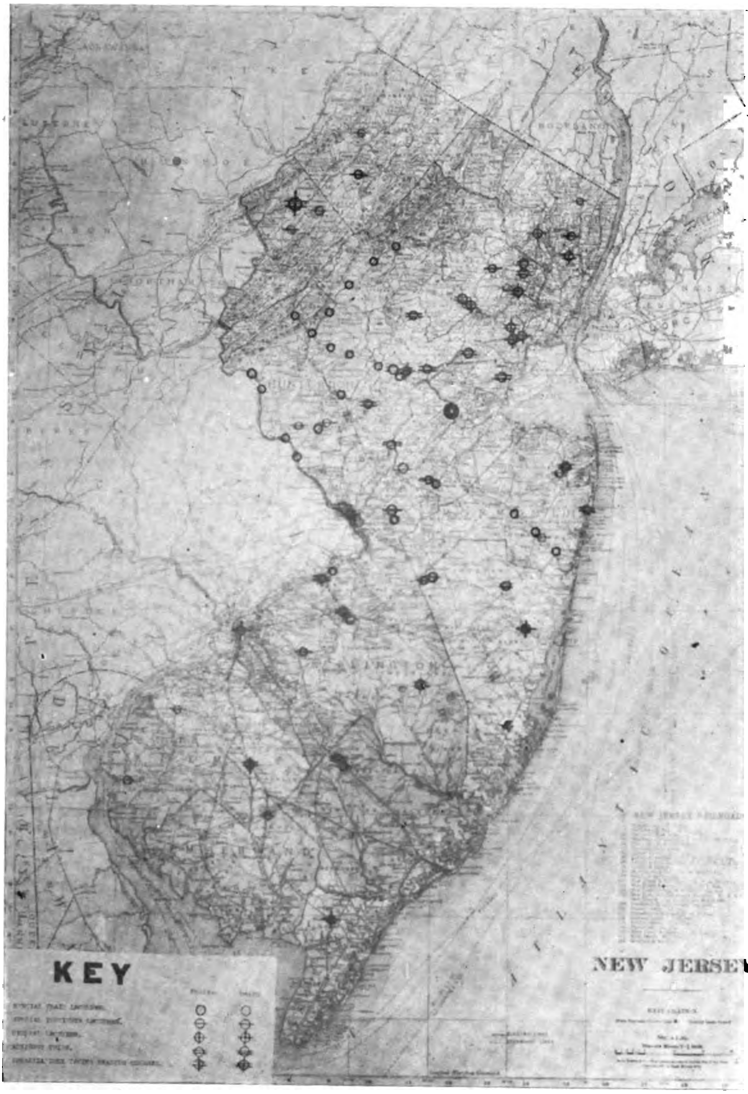
The annual meeting of the International Association of Poultry Instructors and Investigators was held in August at the University of Maine, Orono, Me., and was attended by the poultry husbandman. Many papers were read and discussions followed covering all phases of poultry experimental work to date.

The meeting of the various poultry societies of the State were attended whenever possible to keep in touch with various lines of practical and scientific endeavor and to form a closer union and better knowledge with the work of the department.

The department has prepared poultry exhibits for the agricultural institute trains which were run through North and South Jersey under the auspices of the State Board of Agriculture. Extensive educational exhibits were prepared and shown at the Inter-State Fair at Trenton and at the Mount Holly Fair during September and October.

In the following report it has been deemed wise to submit the material under two distinct heads owing to the different character of the work. Part one will deal with the experimental and educational work, and part two with the location, planning and construction of the new station plant.

CHART (A.)



Showing points reached in the State during the year 1911.

UNIV. OF MICH.

PART I.

EXPERIMENTAL AND EDUCATIONAL WORK.

No. 1. *On the Relation of Moisture to Artificial Incubation.*

The object of the experiment was to determine the effect of varying degrees of atmospheric moisture on:

First. Loss of weight of eggs during incubation.
Second. Per cent. of hatch.
Third. Size and weight of chicks at hatching.
Fourth. Uniformity of hatch.
Fifth. Per cent. of brood to three weeks of age.

In addition to the above, notes were kept to study the immediate effect of varying weather conditions on the relative humidity of incubators and incubator cellar.

Three series of four incubators each were used in arriving at the following results. Prairie State incubators of 120 egg capacity were used.

The first series was started April 2d and the hatch was removed April 23d, the second set being started immediately after the machines had been carefully disinfected with a 5 per cent. solution of creolin and aired for 18 hours. The third lot were set May 16th, after the machines had been carefully cleaned and aired as on April 23d.

The first series were run through with a mixed lot of eggs, mostly White Leghorns and Barred Plymouth Rocks, an equal number of each breed eggs being placed in each machine. The second and third set were run with White Leghorn eggs only.

The incubators in every case were run at an average temperature of 103 degrees, and the moisture supplied by means of the sand tray, accompanying the machines. The temperature of the incubators was taken by means of a standard thermometer with the bulb placed on a level with the top of the eggs. Tycos silk wick hygrometers were used to record the moisture in the machines and a standard wet and dry bulb thermometer was used to determine the relative humidity of the incubator cellar.

The following tables show the results of the hatches:

SERIES No. 1.

PRELIMINARY TEST.

TABLE No. 1.

No. of Inc.	How run.	No. eggs.	Breed.	Av. wt. at start.	Av. wt on 19th day.	Av. loss.	Av. R. H. in. Inc.	Vigorous chicks hatched.	Cripples.	Av. wt. per chick at hatching.	% hatch of fertile eggs.	% hatch of total eggs.	% brood to 8 weeks.
8	Moisture	134	Mixed	.154	.112	.042	40	41	2	.082	35.04	30.70	86.6
9	Moisture	140	Mixed	.153	.110	.043	48	55	3	.089	42.39	39.28	91.4
10	Dry	140	Mixed	.150	.094	.056	29	41	6	.071	30.82	29.28	61.0
11	Moisture	130	Light Brahma	.151	.110	.041	46	28	4	.082	40.79	*20.14	72.8

AVERAGE RESULTS FROM FOUR INCUBATORS IN SERIES NO. 1.

No. of Inc.	How run.	No. eggs.	Breed.	Av. wt. at start.	Av. wt on 19th day.	Av. loss.	Av. R. H. in. Inc.	Vigorous chicks hatched.	Cripples.	Av. wt. per chick at hatching.	% hatch of fertile eggs.	% hatch of total eggs.	% brood to 8 weeks.
..	Moisture	...	....	.153	.111	.042	48	42	3	.084	39.40	30.04	83.6
..	Dry	...	....	.150	.094	.056	20	41	6	.071	30.82	29.28	61.0

* Due to low fertility.

It will be noted that in the first series three machines, Nos. 8, 9 and 11, were run with moisture, and No. 10 dry.

The results all went to show that the increasing of the relative humidity was desirable from a practical standpoint. It will be seen that the loss of weight during incubation was much less on the average, where moisture was increased; also that the per cent. of hatch of fertile eggs was greater and that the per cent. of brood showed a decided increase over the dry hatch. Probably the greatest advantage noticed was the increased weight of the moisture hatched chick at hatching, the average being .084 pounds for the moisture against .071 pounds for the dry. The per cent. of cripples was greater where no moisture was used in the machine.

SERIES NO. 2.

Series No. 2 was run as a check on Series No. 1, but owing to a varying per cent. of fertility in the different machines the results were not uniform in every point and the detailed figures will not therefore be given. The results in the main, however, substantiate the conclusions drawn from No. 1.

SERIES NO. 3.

Series No. 3 was run as a final test and the results are shown in the following table:

TABLE No. 2.

No. of Inc.	How run.	No. eggs.	Breed.	Av. wt. at start.	Av. wt on 19th day.	Av. loss.	Av. R. H. in Inc.*	Vigorous chicks hatched.	Cripples.	Av. wt. per chick at hatching.	% hatch of fertile eggs.	% hatch of total eggs.	% brood to 3 weeks.
8	Dry	125	White Leghorn	.126	.100	.026	58	66	6	.079	55.0	52.4	46.2
9	Dry	125	" "	.132	.112	.020	53	83	4	.079	69.1	66.4	08.4
10	Moisture	125	" "	.127	.111	.016	64	85	0	.080	69.6	64.0	86.0
11	Moisture	125	" "	.127	.114	.013	71	85	2	.082	69.6	64.0	93.0

AVERAGE RESULTS FOR FOUR INCUBATORS IN SERIES NO. 3.

..	Moisture	...	....	.127	.1125	.0145	68	85	1	.081	69.6	64.0	89.5
..	Dry	...	....	.129	.1110	.0230	56	74	5	.079	62.0	59.4	52.3

* The increased relative humidity in series three as compared with series one is due largely to the fact that the floor of the incubator cellar was kept moist at all times in addition to the moisture added to each machine individually.

One hundred and twenty-five eggs were used in each of the four machines which had been used in the previous two tests. The eggs were all from the same flock of Single Comb White Leghorns, and none of them over eight days old, all having been kept in ideal conditions.

The condensed findings are shown under the average results per hatch. In both machines the loss of weight during incubation was much less where moisture was used. The average being .0145 for the moisture and .0230 for the dry hatch. It is also shown that the loss of weight during incubation has a direct relation to the weight of chicks at hatching time, that when moisture is used evaporation is retarded and much of the liquids of the egg which would be lost with a low relative humidity are conserved and incorporated into the growing embryo. This is of very important consideration to the breeder of pure bred and standard poultry as it is one of the surest means of attaining success in breeding birds of standard weight, which are necessary to make the best utility and show birds.

It is also noted that the per cent. of hatch of fertile eggs was greater where moisture was used, being 69.6 against 59.4 without moisture. In the former case 85 chicks were hatched while only 74 in the latter. In addition to this there was an average of one cripple in the moisture machines to five in the dry ones.

The moisture chicks at hatching seemed much fuller and stronger and showed a marked gain in weight, the average from moisture machines being .081 against .079 for those run without moisture. A marked uniformity was noted in the wet machines, in that the hatch came off quickly, there being but eleven hours time from starting to finish of the hatch against 18 hours for the dry machines. This is intended to produce a much more uniform lot of chicks with greater vigor and strength.

The mortality records up to three weeks of age show an average per cent. of brood for the moisture hatched chicks of 89.5 per cent. and 52.3 for the dry hatched. A difference of 37.2 per cent. in favor of moisture. There were a great many chicks in the dry hatched machines who seemed weak and showed lack of vigor and vitality from the first, and it was the death of those during the first five days of the brooding period which made such a low average per cent.

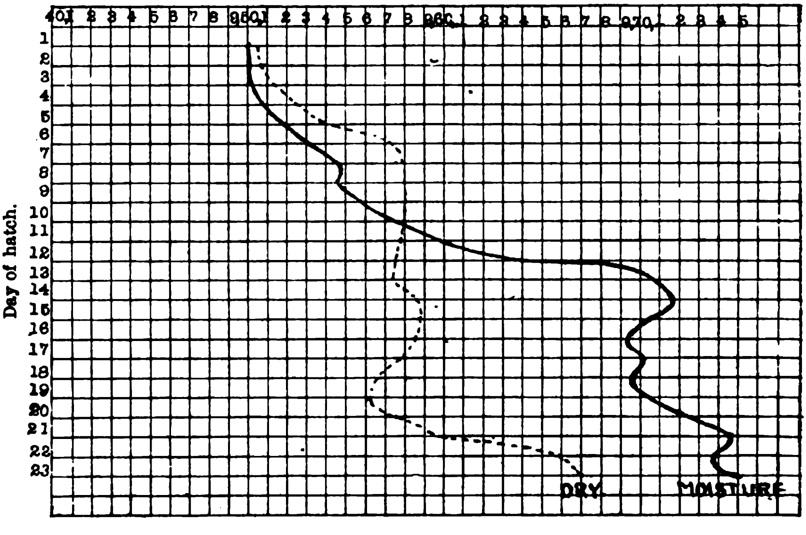
THE PER CENT. OF MOISTURE.

The following plate shows the per cent. of moisture in both the wet and dry machines to a curve, the dotted line shows the dry and continuous line the wet machines.

PLATE 3.

Moisture Curve of Series No. 3—Exp. No. 1.

Degrees Relative Humidity.



In the above plate the increased moisture content from the 19th to the 23d day will be noted, and this was always found whether moisture was supplied to the machine or not, and is doubtless caused by the presence of the young chicks and the evaporation of the moisture during the process of drying off.

As will be seen from the curve the aim was to have the maximum moisture during the second and third weeks to check evaporation, and especially about the eighteenth to the nineteenth day to aid the chicks in getting out of the shell. The average relative humidity in series three in the room was 60 per cent. This shows a difference of 4 per cent. between dry machines which registered an average of 56 per cent. and a difference of 8 per cent. between the wet ones, which registered an average of 68. The cellar floor was kept moist during the last series, which accounts for the greatly increased humidity as compared with the first. The warmer weather being another cause which would hasten evaporation and hold more moisture in suspension.

It was found that by comparing the room readings each day with outside weather conditions that during damp, wet weather there was a decided rise in the humidity of the room, but that this effect was scarcely noticeable unless the damp weather continued for two or more days; a one day rain or cloudy weather made no difference on the per cent. of moisture in the cellar. The moisture and temperature conditions were very uniform, showing that the incubator cellar was well adapted to the purpose. The space used was a half cellar 16 by 30 feet, with eight feet head room, a full bank on the south side and the entrance and light admitted from the north where there was a two foot bank with the rest of the brick wall exposed. The floor was sand, which made an excellent material for holding the water which was used to raise the moisture content of the cellar.

Incubator cellars vary greatly, and it is necessary to determine the average moisture content of the cellar in use, under different conditions, before deciding how much must be added to the machines.

In addition to the above mentioned incubators a number of different makes of machines were tried out with and without moisture to determine the effect of supplying moisture. In an advertised non-moisture incubator, in nearly every case there were decided benefits noted even where they were run in a cellar with a normal relative humidity of 60 degrees, when moisture was added.

CONCLUSIONS.

The following conclusions can safely be drawn from the previous experiments which are in themselves preliminary to more detailed and scientific work which will follow.

The increasing of the moisture content in the incubator to within certain limits will:

First. Increase the per cent. of hatch.

Second. Produce chicks which weigh more at hatching time and which are much larger in size and more vigorous.

Third. Produce a greater uniformity of hatch, both from the standpoint of length of time from piping to complete hatching as well as in the uniformity of the chicks themselves.

Fifth. Produce chicks which are much easier to brood successfully.

Sixth. The best way to supply this moisture is to raise the moisture content of the room itself to as high a point as practical and then bring the machines to the required degree by the use of sand or water trays under the eggs.

EXPERIMENT NO. 2.

A COMPARISON OF TWO METHODS OF FEEDING BABY CHICKS.

The object of this experiment was to determine the effect of a wet versus dry system of feeding upon:

First. Mortality.
Second. Gain in weight.

The idea was to continue it only through the delicate age of the chick, after which time it is a well established fact that a wet system of feeding will produce a more rapid gain in weight which is desirable in the feeding of broilers, while a cracked grain ration and dry mash is best for maturing pullets and stock to be used for breeding. With this in mind the experiment was continued for a period of three weeks, after which time with proper care the system of feeding has little effect upon mortality. One hundred and forty-four White Leghorn chicks hatched the same time from the same machine were selected for the work; they were divided equally between four Prairie State Outdoor Brooders, numbered 1, 3, 5 and 9, 36 in each flock. All four brooders were given the same treatment throughout, with the exception of feeding and the temperature maintained as near equal as possible, there being no variations greater than 5 degrees either way from the average.

The brooders were started April 15th, and the chicks moved to them from the incubator on the 18th, the hatch having come off on the morning of the 17th.

During the first three days of the brooding period all brooders were treated the same, as follows:

No food was given until the morning of the 19th with the exception of grit, shell and water which were supplied in abundance when the chicks were put in the brooder. On the morning of the second day in the brooder a little rolled oats were fed, the idea being to give them something which would attract their attention and start them looking for food in the litter; only enough was fed so that it would be cleaned up by noon, from which time the following mixture was fed five times a day until the third day when the two systems were started.

MIXTURE FED TO ALL BROODERS FOR FIRST THREE DAYS.

Equal parts of cracked corn, cracked wheat and rolled oats by measure. Water, grit and shell were kept before them all the time.

Starting on the morning of the fourth day from hatching the following rations were fed, brooders 1 and 3 being selected for the wet mash, and 5 and 9 for the dry feeding:

WET MASH RATION FED TO BROODERS 1 AND 3.

Bran	50 lbs.
Sifted ground oats	25 lbs.
Corn meal	25 lbs.
Meat scrap	5 lbs.
Charcoal	3 lbs.

The above mixture was fed, slightly moistened with water and milk, four times a day from the third day. The feeding hours being seven, ten, two and five o'clock. A feeding of equal parts of fine cr. corn and wheat was given at noon and an abundance of grit and shell were kept on the floor at all times. As much of the wet mash was fed each time as the chicks would clean up quickly and none whatever was left in the troughs from one feeding to the other. The small troughs were scalded three times a week to keep them sweet. The per cent. of meat scrap in the above ration was gradually increased until at the end of three weeks they were getting 8 per cent.

DRY CRACKED GRAIN RATION FED TO BROODERS 5 AND 9.

Fine cracked corn	50 lbs.
Fine cracked wheat	50 lbs.
Chopped oats	10 lbs.
Oat meal	5 lbs.
Chopped peas	10 lbs.

The above ration was fed in the fine litter on the brooder floor five times a day from the third day. The feeding hours being seven, ten, twelve, two and five o'clock. As much of this grain ration was fed each time as they would clean up between feedings and yet be hungry for more at the next feeding.

Starting at the fourth day the chicks receiving the cracked grains only were given a dry mash in small hoppers composed of bran and 5 per cent. of beef scrap. This was kept before them all the time, and the percentage of beef scrap gradually increased until at the end of the three weeks they were getting 8 per cent. An abundance of grit, shell and charcoal were kept before the chicks in all four brooders.

The brooders were given a thorough cleaning and disinfecting each week, and everything done to maintain uniform conditions and healthy birds. There were no outbreaks of disease or other trouble which would tend to influence the final results.

The following table shows the mortality and the gain in weight of the different brooders for the three weeks period.

PLATE 4.

MORTALITY AND WEIGHT OF BABY CHICKS.

	Brooder 1.		Brooder 3.		Brooder 5.		Brooder 9.	
	M.	W.	M.	W.	M.	W.	M.	W.
Day.		lbs.		lbs.		lbs.		lbs.
1	..	.081	..	.079	..	.080	..	.080
2	..	....	..	....	..	....	..	....
3	..	....	1	....	..	....	..	....
4	..	....	1	....	..	....	..	....
5	1	....	1	....	1	....	..	....
6	1	....	1	....	1	....	2	....
7	2	.140	..	.131	1	.128	..	.124
8	4	....	2	....	1	....	1	....
9	..	....	1	....	..	....	1	....
10	1	....	..	....	..	....	..	....
11	..	....	1	....	..	....	..	....
12	1	....	..	....	1	....	..	....
13	..	....	1	....	1	....	..	....
14	1	.198	2	.190	..	.170	..	.165
15	..	....	..	....	..	....	..	....
16	..	....	..	....	..	....	..	....
17	1	....	..	....	..	....	..	....
18	..	....	..	....	..	....	..	....
19	..	....	..	....	..	....	..	....
20	..	....	..	....	..	....	..	....
21	..	.265	..	.259	..	.210	..	.200
	—		—		—		—	
Total mortality	12		11		6		4	
Per cent. of mortality	33.3		30.5		16.6		11.1	
Per cent. of brood	66.6		69.5		83.4		88.9	

AVERAGE MORTALITIES.

	Wet.	Dry.
Per cent. of mortality	31.9	13.9
Per cent. of brood	68.2	86.2

Difference in favor of dry system of feeding 18 per cent. less mortality.

AVERAGE GAIN IN WEIGHT COMPARED.

	Wet.	Dry.
At beginning	.080 lbs.	.080 lbs.
End of first week	.135 "	.126 "
End of second week	.194 "	.167 "
End of third week	.262 "	.205 "

Average gain in weight per chick for three weeks, wet, .182; dry, .125.

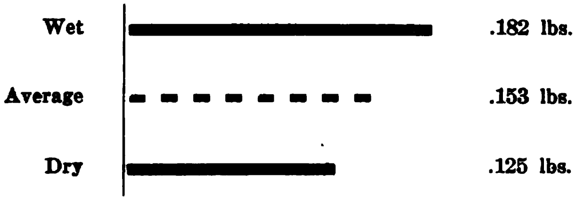
Difference in favor of wet mash feeding, .057 lbs. greater average gain in weight.

From the above table and summary it will be seen that the advantage in gain in weight lay with the wet mash system of feeding, while on the other hand the greatest per cent. of brood was obtained by feeding the dry cracked grains and dry bran mash.

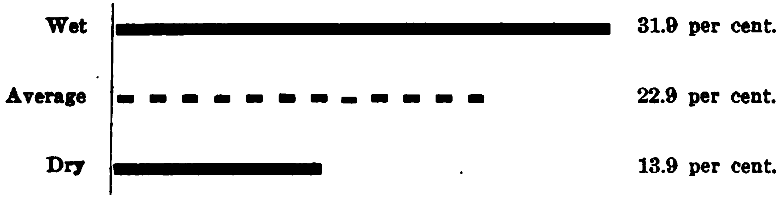
These results are graphically represented in the following diagrams.

PLATE 5.

SHOWING DIAGRAMATICALLY THE AVERAGE GAIN IN WEIGHT TO THE END OF THREE WEEKS.



SHOWING DIAGRAMATICALLY THE AVERAGE PER CENT. OF MORTALITY TO THE END OF THREE WEEKS.



SUMMARY.

The results of this preliminary work in chick feeding shows:

First. That a wet mash system of feeding will produce an increased gain in weight over dry system of feeding.

Second. That this slight increased gain in weight is much more than off-set by a greatly increased mortality where the wet mash system is used.

Third. This injurious effect of the wet mash as shown by the increased mortality is not noticed to any extent after the second week, showing that after that time the chicks' digestive system has developed to such an extent that it can handle the moist feeding with no detrimental results.

Fourth. The practical application of the above results would be to feed the baby chick for the first two weeks with cracked grains and dry mash so as to get him safely through a critical growth, paying especial attention during this time to health and vigor, and after this critical period has passed that the future system of feeding would be governed largely by the purpose in view. If a rapid increased gain in weight was the object as broiler raising, wet mashes could safely be fed. Where as if the maturity of the breeding stock was the main object, a dry mash supplemented with cracked grains would be the more practical, considering that a normal development at the least possible cost is desired.

A STUDY OF THE BEST BROODER TEMPERATURE.

The objects of the study were to determine:

First. The effect of an extremely high hover temperature on the per cent. of mortality.

Second. The effect of an extreme variation in hover temperature, both ways from normal. upon the per cent. of mortality.

Third. The most desirable temperature for best results.

The work was started May 4th, 1911, with four Prairie State outdoor brooders. Two hundred white Leghorn chicks were used, fifty in each brooder. They were hatched on May 2d in a Cyphers 250 egg machine. The experiment was continued for a period of four weeks, during which time all factors of care and management were uniform with the excepton of temperature which was varied as follows:

Brooder No. 1 was started with a hover temperature of 110 degrees F. and a high average was maintained during the four weeks.

Brooder No. 2 was started at 102 degrees F., and wide extremes were run varying from 86 degrees to 120 degrees F.

Brooder No. 3 was started at 100 degrees F. and kept constant for the first two days after which it was lowered gradually about one-half a degree a day during the remainder of the period.

Brooder No. 4 was started at 90 degrees and kept so for the first two days, after which it was gradually lowered one-half a degree a day during the remainder of the period.

The following plate shows average daily hover temperature and mortality in the four lots.

PLATE 6.

EXPERIMENT NO. 3.

A STUDY OF THE BEST BROODER TEMPERATURE.

Temperature and Mortality Record.

	Brooder 1.		Brooder 2.		Brooder 3.		Brooder 4.	
Day.	Temp.	Mort.	Temp.	Mort.	Temp.	Mort.	Temp.	Mort.
1	110	..	102	..	100	..	90	..
2	110	..	99	..	102	..	91	..
3	114	1	96	1	101	1	93	1
4	116	..	90	..	100	..	90	2
5	118	1	108	5	98	..	89	..
6	112	..	100	2	101	..	88	1
7	109	..	116	3	98	..	90	..
8	113	1	98	1	99	..	89	1
9	116	..	120	..	97	..	87	..
10	118	1	112	3	95	..	91	2
11	112	2	92	1	96	1	88	..
12	116	1	86	1	96	1	85	..
13	113	2	113	1	97	..	86	..
14	116	..	109	2	95	..	85	..
15	114	1	120	..	94	..	81	1
16	114	..	94	3	91	..	83	..
17	116	1	88	..	90	1	88	..
18	116	3	116	2	92	..	86	..
19	113	1	114	3	94	..	81	2
20	110	..	94	2	96	..	79	1
21	106	3	110	1	90	..	81	..
22	108	1	107	1	90	1	82	..
23	107	..	93	1	85	..	80	1
24	110	..	118	..	89	..	80	..
25	116	2	110	1	93	..	82	..
26	111	..	91	..	92	..	76	..
27	110	..	102	..	88	..	78	..
28	106	..	98	..	85	..	74	..
Total mortality		21		34		5		12
Average temperature,	112		104		94		85	
Per cent. of mortality,		42		68		10		24

It was found that in brooder 2 where a great variation in temperature was maintained the greatest mortality occurred being 34 or 68 per cent. The greatest losses occurring usually at or immediately after a great variation either way from the normal.

In Brooder No. 1 where a high uniform temperature was maintained a great loss occurred, especially during the second and third weeks, the chicks seemed to constantly grow weaker, and the dead ones would be found outside of the hover, death usually occurring during the day. The excessive heat caused them to lose vitality, and as they grew weaker they seldom left the brooder to go out doors.

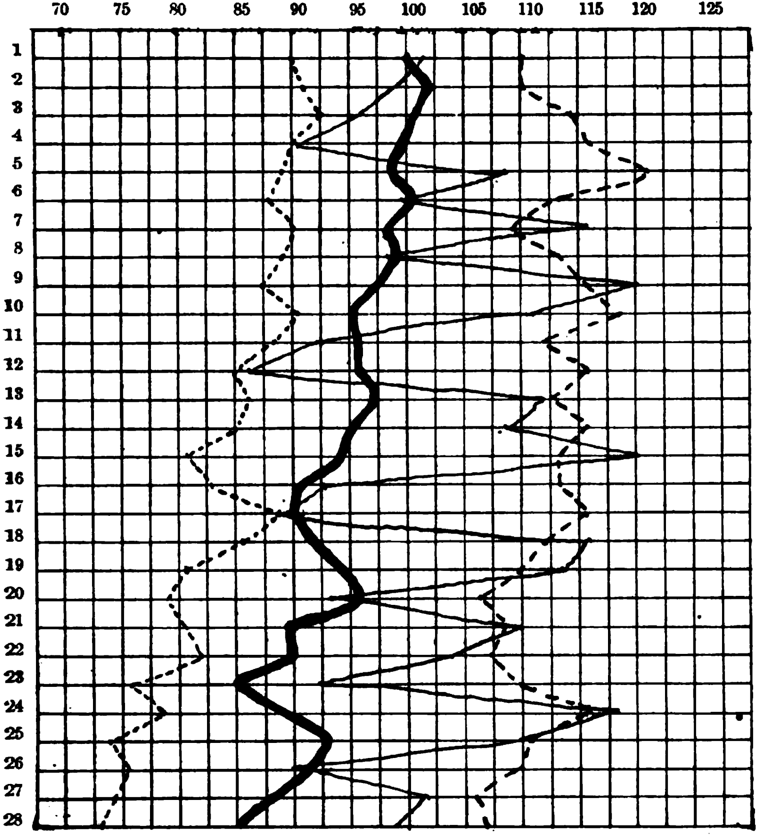
With Brooder 3 and 4 the results tend to show that the most desirable hover temperature for Leghorns, for the first four weeks, where they have cool brooder compartments separate from the hovers is an average of about 94 degrees. Starting with 100 and gradually lowering the hover heat about one-half a degree a day after the third day.

The results from brooder 4 tend to show that an average temperature of 85 degrees for the first four weeks is too low, as there was a mortality of 12 or 24 per cent. This increased death rate was due in nearly every instance to crowding at night in an endeavor to keep warm and could easily have been avoided by a slight increased amount of heat.

The following diagram shows the temperature curves of the four brooders. The heavy black line being that of Brooder No. 3, which represents the approximate ideal.

PLATE 7.

Temperature Curves of four brooders in temperature experiment.

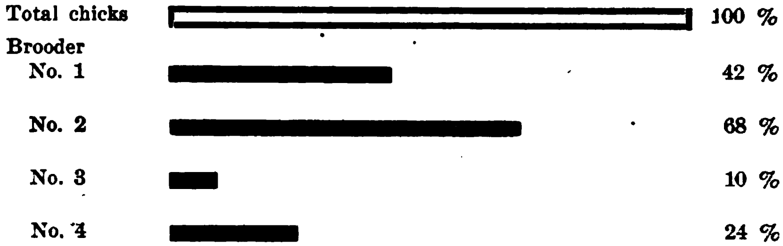


Brooder No. 1.	High Average temperature.	- - - - -
Brooder No. 2.	Great Variation.	—— ——
Brooder No. 3.	Normal.	▬
Brooder No. 4.	Low Average temperature.	....

Diagram showing the relative mortality in the four brooders.

PLATE 8.

DIAGRAM SHOWING RELATIVE MORTALITY IN THE FOUR BROODERS.



While the foregoing studies are limited and preliminary to more extended work, yet they point to valuable practical conclusions which should be noted, especially as they corroborate other work done along the same line.

CONCLUSIONS.

First. That an excessive high temperature continued for many days will weaken the vitality of the brood and cause a heavy mortality.

Second. That a wide variation in temperature, especially if the changes from one extreme to the other are rapid, will cause a large death rate. The deaths occurring at or immediately after the most extreme variations either way.

This factor of temperature variation is responsible for much of the mortality in artificial brooding.

Third. The experiment shows the most desirable hover temperature to be approximately as follows:

First week	100 degrees.
Second week	96 degrees
Third week	92 degrees.
Fourth week	88 degrees.

A good rule for desirable hover temperature is to keep the hover warm enough so that the chicks will spread out over the floor and not crowd. On the other hand it should not be hot enough to cause panting.

Fourth. With leghorn chicks it is not desirable to run the hover at a low average, as they attempt to keep warm by crowding, and much loss will follow, caused largely by suffocation and loss of vitality by a general weakened condition.

EXPERIMENT No. 4.

THE PRACTICABILITY OF THE NEW YORK STATE GASOLINE BROODER HOUSE.

As our poultry plants are constantly increasing in size and numbers there has been an increased demand for an inexpensive brooding system for a medium number of chicks. Until recently a poultryman raising from five hundred to one thousand chicks had to choose between the small outdoor colony brooder of fifty capacity or an expensive long house equipped with either individual brooders or continuous hovers heated from a central plant. In the former case the expense in equipment was heavy, due to the large number of brooders which must be purchased and the amount of labor required was exceedingly great and therefore expensive. With the latter method an exceedingly heavy investment in building and heating plant was required.

A new idea in brooder design and construction has been recently brought out by the poultry department of Cornell University. It is known as the New York State Gasoline Brooder House, and as it has proven its efficiency and practicability, we take pleasure in recommending it to the New Jersey poultrymen as an economical and handy brooder for the average flock.

DESCRIPTION OF BROODER.

The house is eight feet square, having a double board floor with paper between and is raised from the ground twelve inches by means of two 2 x 12 inch runners on the front and back. The sides of the building extend perpendicular to the floor for twenty-four inches, upon which is a steep pitch gable roof seven feet from apex to floor, giving the entire house the appearance of the (A) type of construction.

The walls are made of matched lumber covered with building paper, the heat is furnished by means of a blue flame gas torch placed in a metal burner box under the center of an insulated galvanized hover, the fuel being supplied by gravity from an elevated storage tank in the apex of the roof.

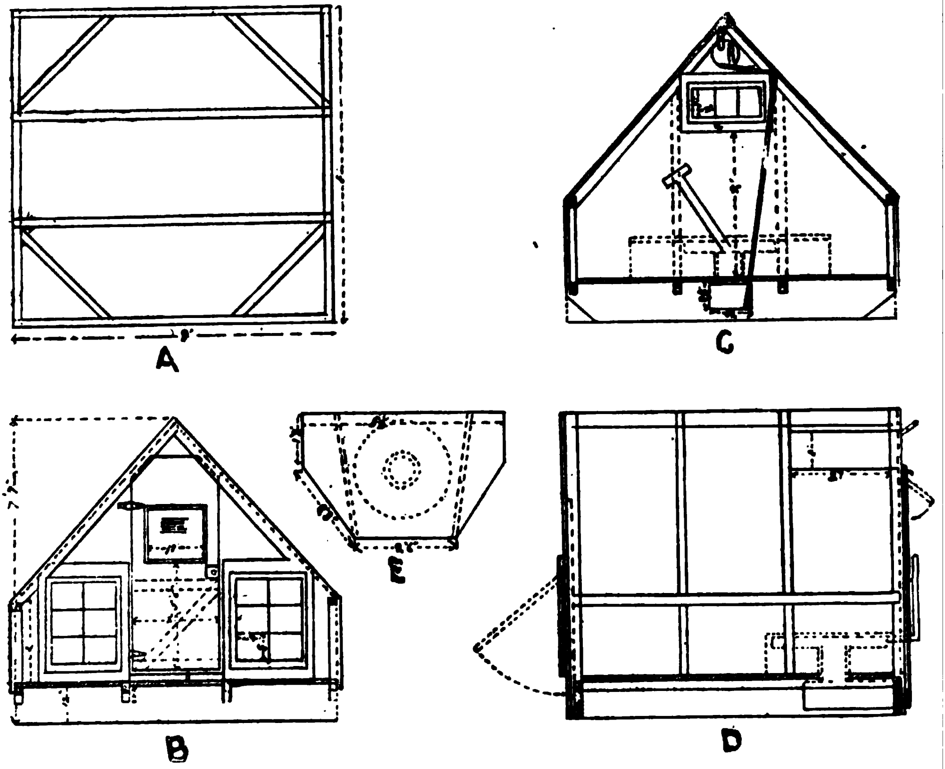
The brooder is adequately lighted and ventilated and furnishes enough head room to work in comfortably.

The metal hover is twenty-four inches in diameter, above which is a hover board five feet long by three feet wide which gives ample accommodation for two hundred chicks for from six to eight weeks or until sex can be distinguished.

The following plan of the brooder shows dimensions and details of construction.

PLATE No. 9.

Working plan of the New York State Gasolene Brooder House.



A, Floor plan.
B, Front elevation.
C, Rear elevation.
D, Side elevation.
E, Details of hover.

The following is the list of materials required to build the brooder complete without heater.

LIST OF MATERIAL.

MATERIAL FOR CORNELL GASOLINE BROODER HOUSE.

Foundation, 2—2 x 12 x 8.
Floor joists, 4—2 x 4 x 8.
Floor (double), 65 sq. ft. ship-lap, 1 x 10; 70 sq. ft. 3-in. flooring.
Sides and roof, 250 sq. ft. ship-lap, 1 x 10.
Studding and rafters, 1 x 3 dressed W. pine.
Roofing paper, 300 sq. ft. all over, 120 linear ft.
40 sq. ft. 1 x 10 W. pine T. and G., for door and hover.
2 cellar sash.

The above material can be purchased in New Brunswick for $25. The heater parts complete together with instruction for setting up can be secured from Treman King & Co., Ithaca, N. Y., for $10.90, crated F. O. B. Ithaca.

The cost of the brooder house complete, including all labor, should be approximately $35, which, figuring two hundred chick capacity per brood, gives one the very economical cost of 17½ cents per chick compared with 30 cents with the small capacity outdoor kerosene brooder, and an even greater investment in the extensive long house type.

The following figures show with what success the brooders were used at the College Farm during the past winter and spring.

PLATE 10.

TABLE SHOWING RESULTS OBTAINED BY USING THE GASOLENE BROODERS ON STATION PLANT.

SPRING 1911.

Brooder.	Date.	Number chicks.	Length of brood period.	Number died.	Per cent. of mortality.	Per cent. of brood.
I..........	April 6.	150	6 weeks	32	21.3	78.7
	June 1.	200	6 "	13	6.0	94.0
II..........	April 1.	245	6 "	30	11.1	88.9
	May 16.	114	6 "	12	10.5	89.5
III..........	April 1.	200	6 "	7	3.5	96.5
	May 14.	200	6 "	27	13.5	86.5
Average of six broods,		184.8	6 weeks	20.1	10.98	89.02

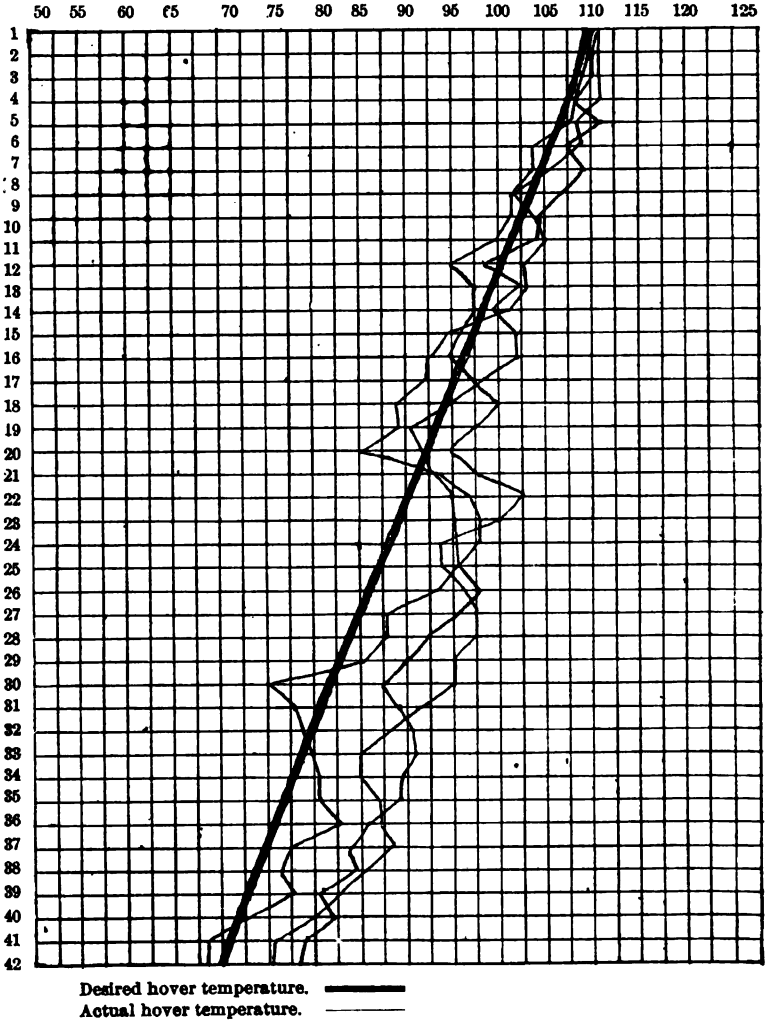
Three brooders were used and two broods run in each brooder to six weeks of age at which time owing to crowded conditions it was necessary to move the females to cold houses and dispose of many of the males.

It will be noted from the above table that out of a total of 1,109 chicks which were placed in the brooders, 121 died during the first six weeks. This shows an average mortality of 10.98 per cent., or 89.2 per cent. brood, which is much higher than results with colony brooders or extensive pipe hovers.

The following curves show the temperature variations in all three brooders during the second series of broods:

PLATE 11.

Temperature variations with Gasolene Brooders.
Spring, 1911. Second Series.



Note regularity of temperature showing little variation due to outside influences.

OTHER USES.

Another advantage of this house is the ease with which it can be converted into a colony house by removing the hover and covering the opening from the burner box. When desired, low perches may be supplied and allowed to rest from plate to plate.

On July 15th last the cockerels and pullets were separated, the latter being placed in the converted brooder houses and given free range and the former confined for rapid meat growth. Each of these houses sheltered 50 pullets until they were six months of age, at which time they were removed to permanent quarters.

Another economical use to which these brooders can be put is the housing of small breeding pens during the winter, the houses being drawn near to the main poultry building where little labor will be necessary in caring for same.

CONCLUSIONS.

From our experience with this type of brooder we find it very desirable from the following points:

First. Will maintain a relatively uniform temperature.

Second. The fuel cost is low.

Third. Owing to large capacity and abundant fuel supply, the amount of labor required per unit of chicks is reduced to a minimum.

Fourth. It will brood successfully with low mortality, if handled properly.

Fifth. Owing to large capacity and simplicity of construction, the investment per unit of brood is small.

Sixth. It is extremely practical owing to the diversity of uses to which it can be adapted.

CAUTION.

There is one point of caution, namely, care must be used in the handling of gasoline as it is highly inflammable material; especial care should be taken when lighting the burner to follow accompanying directions closely.

EXPERIMENT No. 5.

ADVANTAGES OF EARLY VS. LATE HATCHING LEGHORNS.

The following results show the advantage to be derived by the early hatching of birds which are to be matured for winter layers. It is generally recognized that Leghorns owing to their quick maturity can be hatched much later than the heavier, slower maturing breeds and yet be gotten into laying condition at the same time. While this is to a certain extent true, yet this knowledge often tends to influence poultrymen to hatch their Leghorns late in the spring (May and June) in which case the maturity of the pullets at the right season require more expense in care and feed; and the probability of having a large per cent. of immature birds during the early winter months is much more certain than when they are hatched during April.

The following table shows the average monthly gain in weight of two lots of Leghorns hatched April 1st and June 1st, respectively. All conditions of feed and management being identical in both cases.

PLATE 12.

INCREASE IN LIVE WEIGHT OF EARLY VS. LATE HATCHED PULLETS.

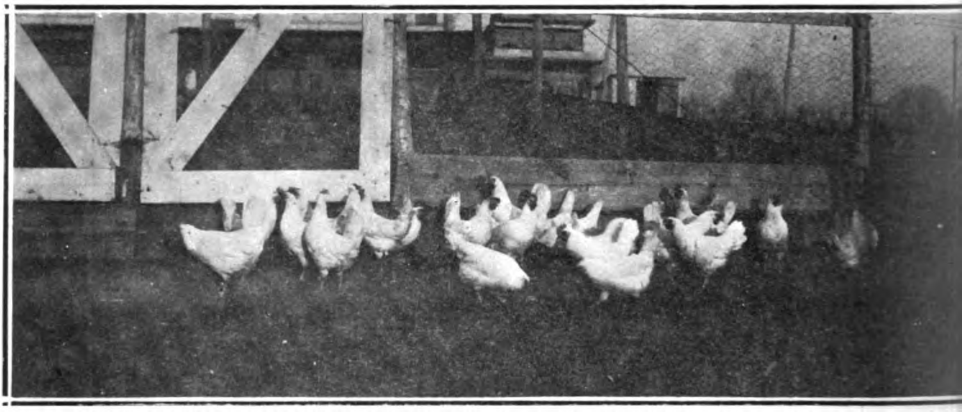
Date.	Lot (A). April hatched.				Lot (B). June hatched.			
	Age. Months.	No.	Av. Wt. lbs.	Gain. lbs.	Age. Months.	No.	Av. Wt. lbs.	Gain. lbs.
July 1	3	50	1.47	..	1	50	.300	....
July 15	3.5	50	1.81	.34	1.5	45	.402	.102
Aug. 15	4.5	48	2.50	.69	2.5	44	.870	.468
Sept. 15	5.5	48	3.30	.80	3.5	44	1.21	.34
Oct. 15	6.5	48	4.05	.75	4.5	42	2.10	.89
Nov. 15	7.5	47	4.70	.65	5.5	42	3.00	.90

Average weight of lot (A) on November 15 was 4.70 lbs.
Average weight of lot (B) on the same date was only 3.00 lbs.
Giving an increased weight of lot (A) over lot (B) of 1.70 lbs.

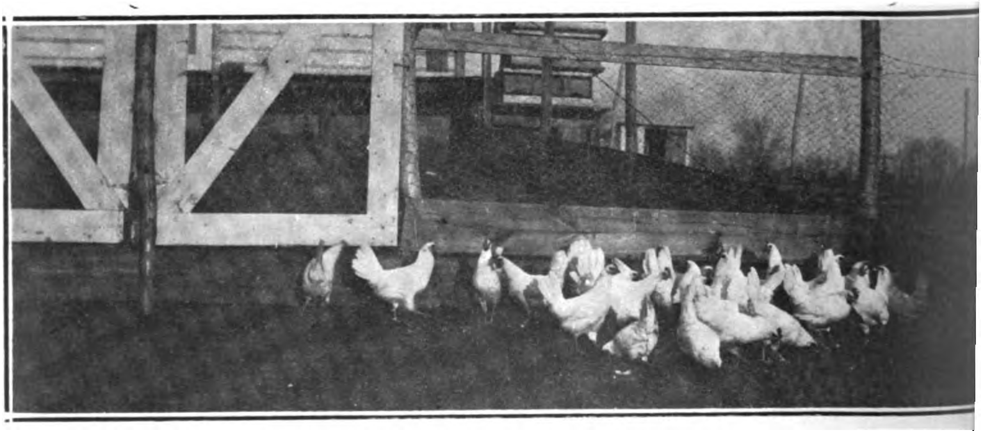
Note the slow gain in weight made by the young chicks of lot (B) during the hot summer months.

From July 15th to November 15th both lots were allowed free range and housed in 4 x 6 colony houses, 50 birds to a house.

PLATE No. 13.



(A.)
Early hatched. Showing maturity and vigor.



(B.)
Late hatched. Showing lack of proper maturity.

They had free access to dry mash, an abundance of green food and shade.

The following plate shows the two lots of pullets when they were put in winter quarters, November 15th, 1911. At this time sixteen of the early hatched birds had commenced laying and only two of the late hatched flock.

CONCLUSIONS.

Under the average farm conditions when forcing is not resorted to in maturing pullets the best months for hatching are March and April; with Leghorns not later than the middle of May. Late May and June do not leave time enough for the quick maturing breeds to attain a normal development by early winter.

EXPERIMENT NO. 6.

PRELIMINARY EXPERIMENT TO DETERMINE THE ADVANTAGE OF EARLY SELECTION FOR VIGOR.

Considerable work has been done at some of our experiment stations to determine the value of vigor as shown in young chicks as an indication of an inherited vitality which will be even more pronounced at maturity and which will be exemplified in egg laying and meat producing qualities.

The following test was run in order to determine the practical value of selection for vigor. Two lots of White Leghorn chicks four weeks of age were selected for the work. There were fifteen chicks, both male and female, in each lot at the beginning, they being hatched in a Cyphers Incubator run with moisture. The fifteen chicks in lot (A) were selected at four weeks of age as showing strong constitutional vigor; while lot (B) was selected as representing those showing in a marked degree low vitality and a weak constitution.

The following table shows the monthly gain in weight and mortality of these two lots of chicks from four weeks to eight months of age:

PLATE 14.

SHOWING VALUE OF SELECTION FOR VIGOR.

	Lot (A).				Lot (B).		
Date.	Age.	No.	Av. Wt. lbs.	Gain. lbs.	No.	Av. Wt. lbs.	Gain. lbs.
May 1..........	4 weeks	15	.274	....	15	.210	....
June 1..........	2 months	15	.661	.387	15	.508	.278
July 1..........	3 "	13	1.134	.673	13	.903	.305
Aug. 1..........	4 "	13	1.864	.730	13	1.254	.351
Sept. 1..........	5 "	13	2.589	.725	13	1.660	.406
Oct. 1..........	6 "	13	3.291	.702	13	2.021	.361
Nov. 1..........	7 "	13	3.921	.630	13	2.329	.308
Dec. 1..........	8 "	13	4.530	.609	13	2.650	.321

Average weight of lot (A) on December 1..........	4.53 lbs.
Average weight of lot (B) on December 1..........	2.65 "
Difference in favor of selection..............	1.88 "

Per cent. of mortality in both lots was the same, 13.3 per cent.

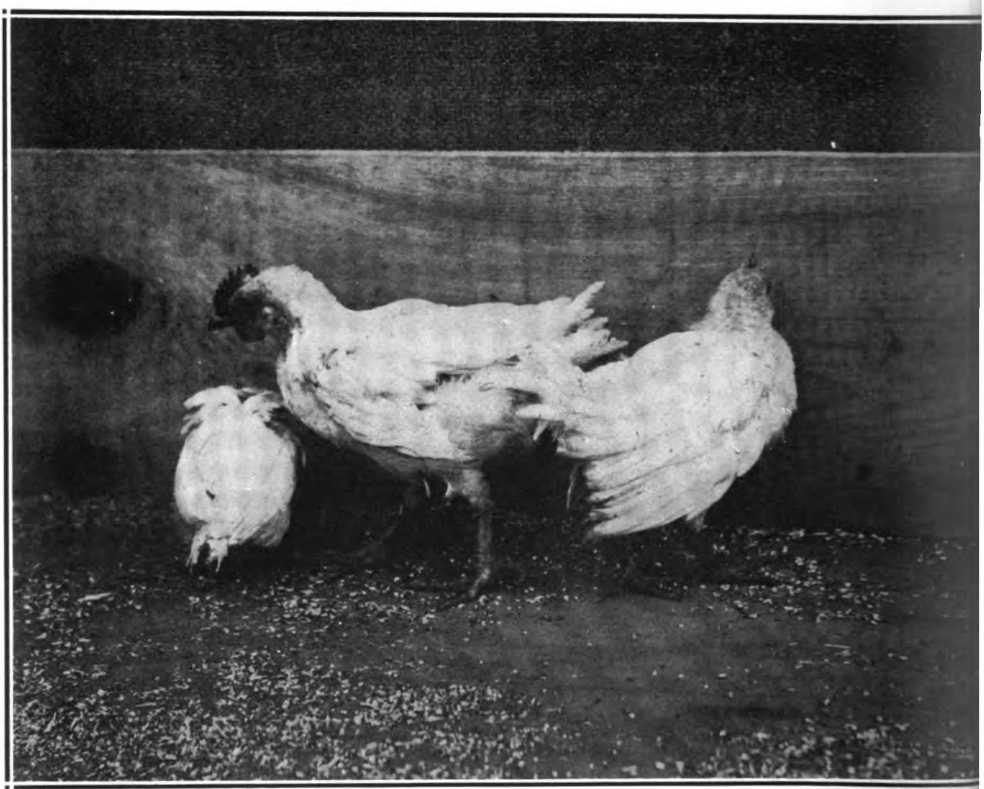
Note the gradual uniform development in lot (A) as compared with the erratic and slow development of lot (B). It will be noted from the above table that gain in weight was the true comparison of the two lots and not mortality. The mortality in both lots being two chicks, due in each case to injury caused by swallowing poultry staples. Those in lot (B) seemed to possess just enough life and ambition to exist, making very slight and in some cases practically no gain in body weight. Under anything but perfect brooding conditions it is probable that the mortality in lot (B) would have been much larger.

The following plate shows the difference in size and vitality of three chicks selected at random from the two groups at eight weeks of age, Nos. 2 and 3 being from lot (A) and No. 1 from lot (B).

Plate 16 shows the two groups complete eight months of age.

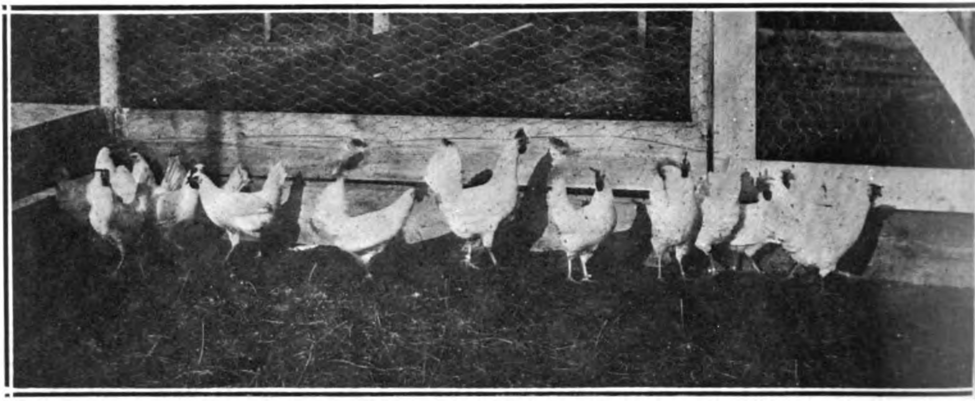
Plate 17 shows five of the best developed specimens in group (A) and (B).

PLATE No. 15.

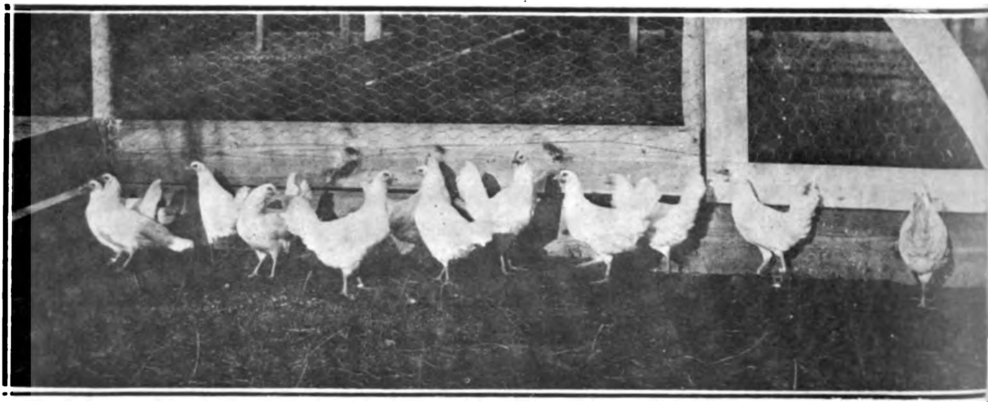


Showing difference in relative vigor at eight weeks.

PLATE No. 16.

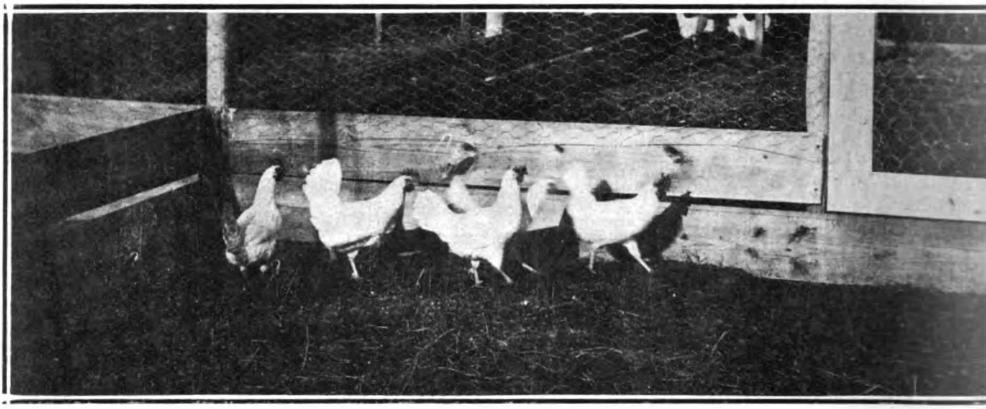


(A.)
Mature birds which were selected at an early date as showing signs of inherited vigor and vitality.

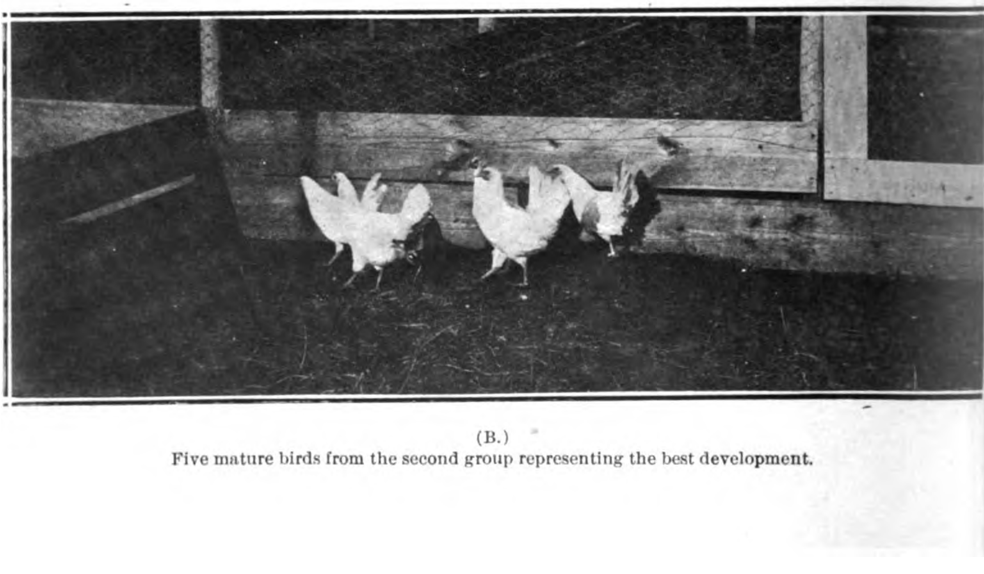


(B.)
Mature birds which were selected at an early date as showing lack of inherited vitality.

PLATE No. 17.



(A.)
Five mature birds from the first group representing the best development.



(B.)
Five mature birds from the second group representing the best development.

CONCLUSION.

The results of this preliminary work show strongly the desirability and practical advantages to be derived by making an early selection of the young chicks, separating those which show lack of inherited vigor and disposing of them for meat if possible at an early date as they cannot be expected to make profitable layers, strong breeders or desirable market poultry.

EXPERIMENT No. 7.

SHOWING THE VALUE OF FREE RANGE, SHADE AND GREEN FOOD IN THE PROPER MATURITY OF PULLETS.

The three requisites for the successful maturity of pullets are free range, shade and an abundance of green food, without these the greatest success cannot be attained. Many small poultry breeders suffer loss and discouragement owing to improper conditions for the growing birds. The following table shows the gain in weight and mortality of two lots of Barred Plymouth Rocks of fifty each. Lot (A) being given free range and housed in a colony house 4 x 6 feet. Lot (B) consisting of the same number of the same age which were confined from May 15th till October 1st in a bare yard 20 x 100 feet. The yard which held group (B) was plowed and seeded to oats twice during the period, but the seed barely germinated before it was devoured. Some green food was supplied in the form of sprouted oats, but this was very limited in amount. Group (A) on free range had free access to growing alfalfa at all times as well as an extended range of pea and oat stubble.

The following table shows the gain in weight and mortality in the two lots from eight weeks at which time the division was made, care being taken to have each lot as uniform in size and vitality as possible by a careful examination.

PLATE 18.

SHOWING THE VALUE OF FREE RANGE IN THE PROPER MATURITY OF PULLETS.

Date.	Lot (A).				Lot (B).		
	Age.	No.	Av. Wt. lbs.	Gain. lbs.	No.	Av. Wt. lbs.	Gain. lbs.
May 15.........	2 months	50	.821	....	50	.813	....
June 15.........	3 "	48	1.580	.749	44	1.373	.560
July 15.........	4 "	48	2.370	.800	43	1.884	.511
Aug. 15.........	5 "	46	3.100	.830	42	2.371	.487
Sept. 15.........	6 "	46	3.820	.720	42	2.892	.521
Oct. 15.........	7 "	46	4.511	.691	39	3.253	.361
Nov. 15.........	8 "	46	4.932	.421	38	3.858	.605

Average weight of chicks in Lot (A) on November 15..	4.932	lbs.
Average weight of Lot (B) on November 15...........	3.858	"
Difference in favor of free range................	1.074	"

Per cent. of mortality in Lot (A) was..............	8	per cent.
Per cent. of mortality in Lot (B) was.............	24	" "
Difference in favor of free range.............	16	" "

Note the slow, irregular increase in live weight in lot (B), and also the heavy mortality during the early part of the test period as compared with the uniform rapid increase in weight and the small death rate in those having free range.

On November 15th the only difference in the two lots was a much greater average live weight in lot (A) and a much more pronounced maturity as shown by the egg yield, which was 7 per cent. for lot (A) and two per cent. for lot (B).

CONCLUSION.

An abundance of range supplied with sufficient shade and access to a constant supply of green food is the most satisfactory condition for the best maturity of pullets.

EXPERIMENT No. 8.

A DETERMINATION OF THE VALUE OF SPROUTED OATS AS A SUCCULENT FEED FOR THE WINTER USE.

One of the essentials of an economical and efficient ration for poultry feeding is the factor of succulence. Differently expressed, there is a great advantage to be derived by having some green feed containing the original vegetable juices to take the place of the green grass which the birds get in the spring and which causes an increased production of eggs at that time.

Many poultrymen find in the fall that they have not provided any or sufficient succulent feed in the form of cabbage, mangels, turnips, potatoes, &c. The object of the following work was to find some substitute for these food materials which would be:

First. Easily handled.
Second. Palatable.
Third. Economical.
Fourth. Efficient as source of food material.

After numerous trials with oats, wheat and barley as the grains to be sprouted, it was found that in every case oats made the best growth in the shortest time, and therefore were used exclusively in the work.

MANNER OF SPROUTING.

Only the best grade of plump heavy feed oats were used, and were handled in the following manner:

Six quarts of clean oats were placed in a 10-cent galvanized pail, and the pail filled with warm water at a temperature of not over 100 degrees, to which was added ten drops of formalin. The oats were allowed to soak in this manner in a warm room for 48 hours, at which time they will have swelled and entirely filled the pail and will have absorbed all of the water. Next they are poured onto a tray of the sprouting rack to a thickness of *one inch.* The sprouting rack used was home made, being built seven feet tall and two feet square, being equipped with seven trays, one for each day in the week, each tray being 24 inches square. The following plate shows the rack used:

Note the oats ready to feed in the bottom rack and gradually diminishing in size as the top is reached.

The rack is kept in a room where the temperature is not less than 60 degrees, and the sprouting oats are thoroughly sprinkled twice daily. In from seven to ten days, depending on the room temperature, the sprouts reached their maximum normal development of about three to four inches after which time if they were not fed they quickly went backwards owing to lack of food material in the seed oat.

It was found that on the seventh day with a room temperature of 75 degrees the oats were in the best condition to feed, having taken up during the soaking and sprouting period three and two-thirds their original weight of water.

The following plate shows the oats on the seventh day ready to feed:

Note the mass of small tender rootlets which make the best kind of succulent feed.

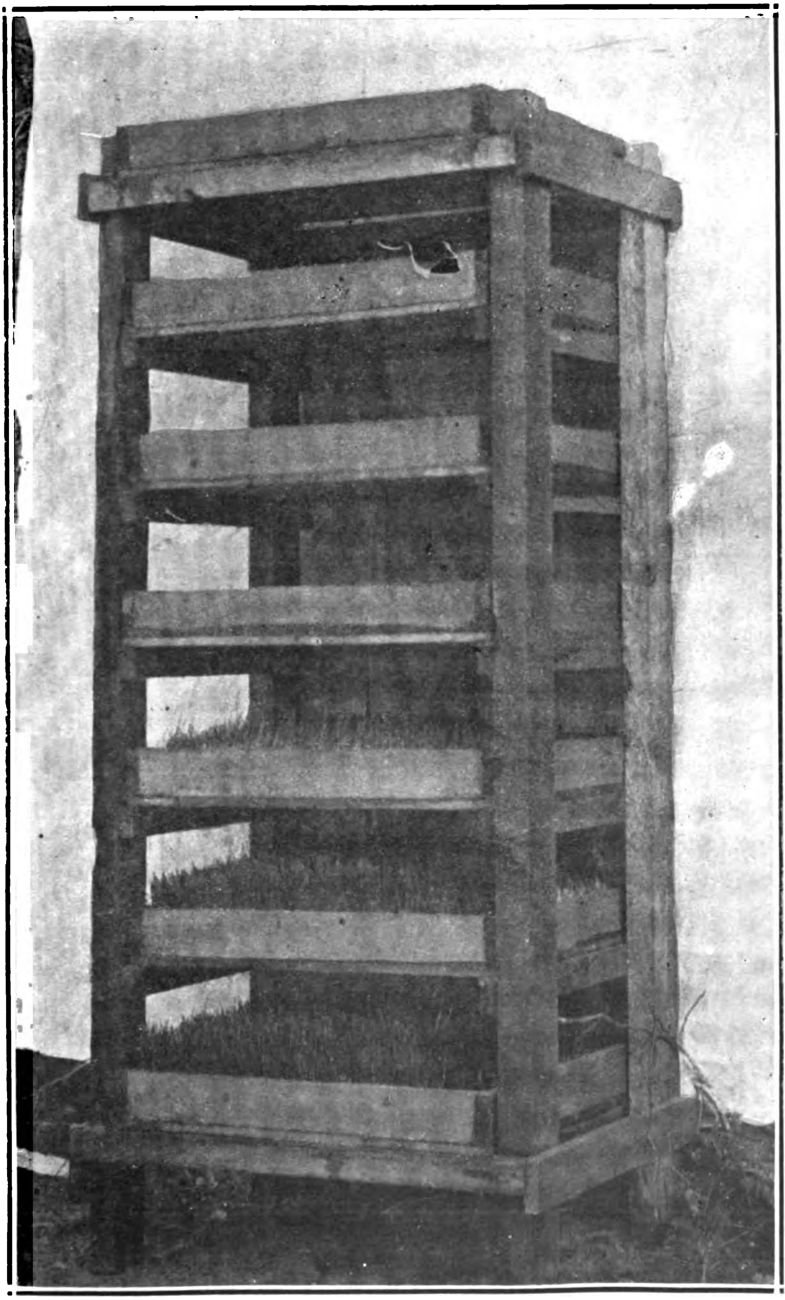
After careful tests in manner of feeding the best way was found to feed the oats in broad, flat, open troughs, placing as much of the green material in the trough at one time as they would clean up immediately, otherwise it was scratched out and wasted. Under average flock conditions it was found that one square inch of feeding surface per bird per day was sufficient to satisfy their appetites and supply the succulence necessary, without causing diarrhoea. The sprouted oats were very palatable, being relished by every bird in the flock. It was tried in some cases with sick birds which would not eat grain, and in nearly every instance was eaten greedily.

The ten drops of formalin which was added during soaking served the purpose of killing the spores of mould and kept the oats sweet during the sprouting period; this addition of formalin is essential to the process.

CONCLUSION.

The following conclusions were reached after an extended use of sprouted oats:

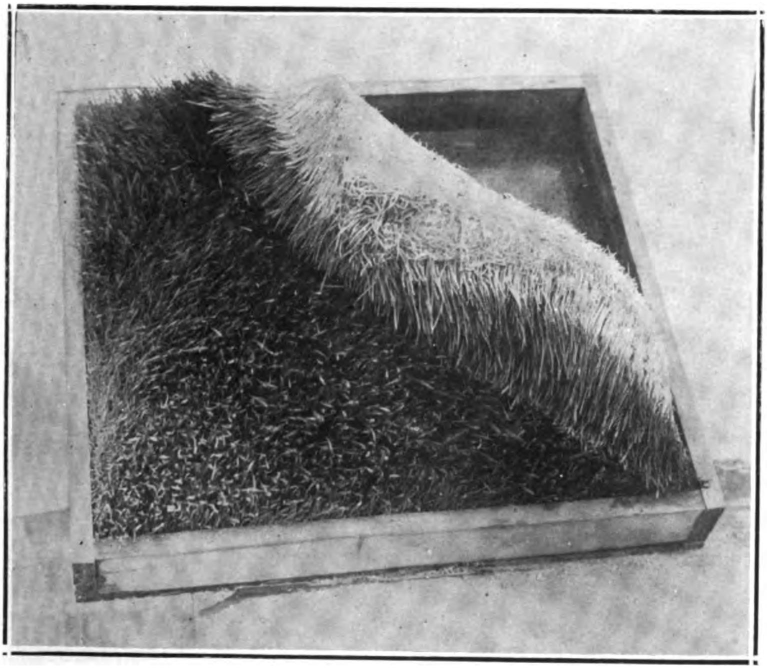
PLATE No. 20.



Sprouting Oat Rack, complete.

UNIV. OF MICH.

PLATE No. 21.



Sprouted Oats ready to feed.

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First. That the sprouting of oats for poultry feeding is a simple process requiring little time and attention and in every case results are certain. A sprouting rack similar to the one pictured above is capable of supplying a continuous quantity of green feed for over 500 laying hens during the winter months.

Second. That oats so prepared and fed to laying birds is very palatable and satisfying, much more so than when fed as whole grain.

Third. That (this method of feeding oats is the most economical method of feeding same, there being 366 lbs. of succulent food material obtained from every hundred pounds of dry feed oats. In every case where the sprouted oats were fed to birds not having received the same immediately prior to present feeding an increased production was noted.

Fourth. Sprouted oats containing approximately the following food nutriments per 100 lbs. is very efficient source of food material compared with other succulent food which could be grown and stored.

Approximately composition of 100 lbs. of sprouted oats in the fresh condition:

Water	75.9
Ash	0.8
Protein	3.2
Fibre	2.5
Nitrogen free extract	16.3
Fat	1.3
Total	100 lbs.

This shows a total dry matter of 24.1 lbs. as compared with 20 lbs. in potatoes; 12 lbs. in beets, and only 10 lbs. in cabbage.

The above analysis of sprouted oats shows a relatively high protein content for a succulent feed of 3.2 lbs. as compared with 2.1 lbs. in potatoes, 1.3 lbs. in beets, and 2.4 lbs. in cabbage.

Fifth. From the above facts it is readily seen that the sprouting of oats is a practical and efficient method of supplying an essential feature of a complete ration (namely succulence) and a trial of its merits is earnestly recommended to all.

Experiment No. 9.

STUDIES IN THE MARKETING OF POULTRY AND EGGS.

Feeling that there are great possibilities open to the poultry raiser of New Jersey if he would use more care and attention in the marketing of his poultry products, the station has undertaken an extensive study of market conditions and requirements with the idea of later offering some practical suggestion whereby individual effort and co-operation the poultrymen can realize financial benefit from the work.

This line of investigational work is being carried out under three distinct methods, as follows:

First. A form of circular letter containing the following questions is being circulated among the retail and wholesale merchants of the State with the request that if they are interested in receiving a better grade of egg that they co-operate with us in bringing it about. So far the response has been very general and a great deal of information has been accumulated which will later be used in bulletin form.

The questions asked are as follows:

Question. Egg Statistics.

1. Give a rough estimate of the number of cases of eggs you bought between May 1, 1910, and May 1, 1911.
2. Do you buy *case count* the year round?
3. If not, when do you buy loss off?
4. Do you make any difference in price between the two methods of buying? If so, how much?
5. What is the per cent. of rots during the hottest month of the year?
6. When you candle your eggs after buying, either loss off or case count, what is the number lost for each case during the following months: Jan. ——; Feb. ——; March ——; April ——; May ——; June ——; July ——; Aug. ——; Sept. ——; Oct. ——; Nov. ——; Dec. ——?
7. If these bad eggs could be eliminated could you not quote higher case count prices? If so, how much per dozen?
8. In case a farmer, or community of farmers, were instructed as to the kind of eggs which were best to sell and would ship direct to you always, could you afford to put a premium upon them above the regular price? If so, how much?
9. What do you consider some of the causes for the larger number of bad eggs coming to you?
10. If we attempt to organize and instruct a community will you pay a premium for first-class, guaranteed eggs?
11. When you candle eggs, how do you grade them?
12. Would you like to have us get out a circular of education for the farmer dealing with proper method of handling and marketing eggs, stating the different market grades and prices for same with practical suggestion how to improve the quality of his eggs?
13. If you wish this, state suggestion which you think would be valuable in such a circular.
14. Do you think that the grading, washing and packing of eggs at home by the farmer, in one dozen cartons, will bring a sufficient increase in price to warrant same?
15. What premium will you pay for eggs so handled and shipped regularly, guaranteed?
16. Will you give us your support in a movement to improve methods of handling and marketing eggs?

Second. A personal study of conditions as they exist in the large market centers is being pursued by members of the staff, in this way inside information is gained which could not be attained in any other way.

Third. The various markets are being actually tested with sample shipments from the Station and by co-operation with local poultrymen, to determine to what actual extent our markets are willing to pay a premium for a first-class product and to determine as far as possible the actual increased cost involved in preparing the product so as to bring this increased price.

The following popular review summarizes the work to date and at the same time offers many practical suggestions which can be acted upon immediately.

A STUDY IN MARKETING EGGS AND DRESSED POULTRY.

1. INTRODUCTION.

Eggs and dressed poultry of a very high quality are produced in large quantities throughout this State. Some of these products reach the consumer in an ideal state, but a certain proportion, through careless preparation, delay in transportation, or lack of knowledge in marketing, fail to bring the profit which they should, to the producer. Much depends upon the wise choice of place and method of selling. Owing to our situation and surrounding conditions the poultry raisers of New Jersey have a variety of ways of disposing of their products to the best advantage. The selection of the manner of selling is a question which can only be settled by each producer for their own benefit.

2. METHODS OF MARKETING AT A DISTANCE.

During the summer and seashore season the resorts furnish the best markets for some classes of poultry products. Other inland small cities and villages offer fair markets for limited quantities the year round. The great bulk of eggs and poultry raised on poultry plants, however, must be marketed where the demand is constant and where quality is demanded and valued. This is necessary not only because it insures a ready sale of all products offered, but it allows opportunity to the producer to gain an added profit, at small cost, by using his knowledge and care in placing a class of products on the market which *will* be above the ordinary competitors and, therefore, bring a premium in price. These opportunities are offered best in the large cities. There is a great lack of knowledge among the producers as to the conditions in the large egg markets and of the proper method to pursue in order to place their goods there in the best possible manner.

Eggs and dressed poultry may be shipped to retail stores, hotels or to private families in these large cities, but this method involves much attention and detail, besides the risk of bad debts. This manner of selling is carried on by a few people, but is only successful where a business man is in charge of it who is able to put much time and care on it. The usual way and an altogether best way, where large quantities are to be sold, is through commission houses. Now, placing your faith in somebody many miles away, to handle your goods and return to you just prices is an arrangement which is found to involve some risk. However, this system when carried out right gives good results; it isn't worth while to study the faults and do what we can to eliminate the amount of risk and cater to the demands of the market. In connection with this work therefore a trip was made and discussions held with some fifteen dealers in poultry products on the commission basis as well as with many other gentlemen there, interested in the trade in one way and another. Having been more or less connected with the selling of farm produce for a number of years the investigator was able to follow up and grasp some of the phases of the subject perhaps, to better advantage than otherwise.

During the year 1910 the total receipts of eggs in the city of New York was 4,376,918 cases, or 131,307,540 dozen. It was estimated that something less than 5 per cent. of this amount are received from nearby States, and that less than 1 per cent., or about 35,000 cases, come from New Jersey. Philadelphia and other large cities, of course, receive large quantities, and the rules and methods which answer best in New York apply equally well to them. It can be readily understood that the amount of work involved in receiving and distributing this enormous quantity of a perishable product is immense. Through many years in which this business has been developed, there has been a sifting and fitting of different men into different places. So now we find some men receiving large numbers of carload lots of eggs from the West. They in turn sell them by hundred case lots or single car lots to other men called jobbers or distributors. The retail store purchases in single case lots or more from the jobber, and so the eggs finally reach the consumer. Although much has been said and written against the middleman it is still a fact that in all probability the middleman will remain as a fixture, and that in large communities his importance will still be considerable.

Of course, where a commodity goes through so many hands before reaching its destination there must be considerable difference between the prices on the two extremities. Here is one advantage of the Jersey egg producer over his Western brother. There is always such a demand for strictly fresh fancy eggs that the carefully prepared Jersey eggs do not need to go through quite so many hands. The nearby producer should ship direct to a jobber or distributor and demand daily returns. The distribution can afford this, and if he is of the right kind will make no objection. He seldom keeps them twenty-four hours, and they should be in the hands of the consumer within two or three days after shipping. On the other hand, careless or poorly graded eggs are ranked as "gathered" and go in with the Western product. An old established firm should be selected to ship to, and where possible a visit made once or twice a year to keep in touch with market conditions and create a feeling of trust and mutual aid between shipper and receiver.

3. METHODS OF MARKETING LOCALLY.

In some sections of the country the egg buyer or collector is the common means of disposal of the eggs by the farmers. It is practised some in this State, but not to any great extent. To farmers in isolated locations it may offer advantages. Where a small poultry raiser is located in or near a village or city and has the inclination, a very profitable retail business may be established. Usually it will pay well to dress the poultry entirely, that is, draw it and cut off the feet and heads, saving the buyer this trouble, and by adding a few cents per pound, makes a satisfactory remuneration to the seller. In eggs it is an excellent plan to have paper cartons holding one dozen and one-half dozen each made and stamped with the farm name. By pasting a gummed label on which is printed a guarantee over the opening, the use of discarded cartons is prevented by other dealers. Sometimes it may be advisable to allow customers of good repute to run up accounts, but on general principles the farmer wants as little as possible to do with credit customers. Bookkeeping is a complex burden to them for which they are not usually adapted.

Selling for cash or trading for other commodities at retail stores is a very common but often unsatisfactory method of selling eggs. It allows the producer little hope of gaining any reputation for his goods, and often allows the store man two profits, one on the eggs and one on the goods the farmer takes in trade. Hotels, restaurants and clubs of good standing may make very good markets for the poultry raiser's products. As a class, however, they are known as slow pay and should be dealt with accordingly. Where the farmer can take his goods to the market and return home with the money in his pocket, he should sacrifice a little in price. This is not often necessary, however, and the retail stores of many cities in New Jersey pay good cash prices all the year round. To get the best results the eggs should be carefully graded and so earn a reputation for themselves which will be their best advertisement..

4. REGULATION AND FLUCTUATION OF MARKET PRICES.

The New York egg and dressed poultry markets because of the vast quantities received fix to a greater or less degree the prices of these products in a large part of the country. Very little is known among the general public and rural communities especially as to how the prices are so regulated. Small egg shippers all over the country speak of the "market price" without knowing how or where it originates. At No. 6 Harrison street, New York, is the Mercantile Exchange Building. This exchange has a membership of several hundred men, all of whom are connected with the buying and selling of poultry and dairy products. The membership is quite strictly guarded and only men of sound financial standing and good business reputation are invited to join. Here at ten o'clock every business day the members gather to buy and sell quantities of these products. From the sales here transacted the dealers gather a very accurate idea of the ratio between the immediate supply and the existing demand. The prices which prevail at these sales are taken as a guide by dealers for that day. The dealers hold that some such basis as this is absolutely necessary. They say without some fixed price to go by, speculation would be indulged in heavily and the handling and storage of eggs would be essentially a gamble. The storage of eggs in the mammoth cold storage houses in New York City and Jersey City has become a most important factor in the control of prices of poultry products. Eggs are bought in the Western States during the early spring when the supply is abundant and the prices are low. They are shipped to New York and stored in a temperature of about 30 degrees. Fresh eggs thus stored remain almost perfect for several months. This wholesale buying in the flush of the season tends largely to hold the price from going any lower. In the late fall and winter when fresh eggs get scarce the cold storage supply is drawn upon to furnish eggs which, although not fresh, yet serve the purpose very well and place this fine food product within the reach of most everyone. No doubt there is much speculation going on, and many cases of rascality occur in the business. Yet this occurs in all lines of commercial trade and in some of a much worse character than in the poultry products line. There are hundreds of sharpers who make a living by sending cards offering attractive prices to shippers. They scour the express offices and hang around the delivery wagons copying the names and addresses of the shippers. Such is human nature that many of the shippers receiving these false quotations immediately send their next consignment to these "Pikers," as they are called. Not until the lapse of weeks and no returns appear do they realize their mistake in not looking up the standing and reputation of the parties before they gave them their goods.

5. CAUSES OF LOSS AND THE REMEDIES.

In the discussion of this phase of the subject opinion was found quite united among the receivers. They are here given in order of importance.

First. Delay in shipping.
Second. Filthy conditions in poultry houses.
Third. Not grading the eggs.
Fourth. Careless packing, using old fillers and crates.
Fifth. Delay in transportation.
Sixth. Shipping to unreliable parties.
Seventh. Keeping males with flock in warm weather.

1. Small raisers are forced to hold their eggs until they get enough to ship. Co-operation with other neighbors has often worked out well. It is better to ship a half case of fresh eggs, which is often done in warm weather, than to hold longer and ship a crate of "held eggs." When it is necessary to hold eggs, keep them in a cool dry place. This is imperative. Moisture about them for a few hours in warm weather causes them to deteriorate, and they are then sold as "musty eggs." In very warm

weather the eggs should be collected twice a day, placed in a cool place and shipped every day or at least twice a week. In carrying them to the station, protect them from the hot sun. Do not allow broody hens in the laying house. A few hours under a sitting hen will cause fertile eggs to start, which the receiver will note the instant he begins to candle them. These are known as "heated."

2. Clean houses keep the fowls in a healthy condition. Clean nests keep the eggs in a healthy condition. Washed eggs go bad very fast. A stiff brush should be used when necessary to clean eggs, never water. Nest material is cheap, and it is much easier to change frequently than to clean the eggs.

3. Local eggs in large markets are graded thus:

Extra Hennery Whites.
Extra Hennery Browns.
Firsts Hennery Whites.
Firsts Hennery Browns.
Firsts Hennery Mixed.
Seconds—
Thirds—
Dirties—

The extras must be all of a uniform large size, perfectly clean, with chalk white shells, not tinted in the least, and only a few days old. The firsts need to be of uniform color and clean, but do not run quite so large. The seconds are smaller or mixed sizes, and thirds still smaller. Often times fresh eggs are sold for half price because they are dirty. During all months but February, March and April, white shelled eggs bring from three to fifteen cents per dozen more than equal quality brown shelled. During the egg flush season in spring, fresh eggs are so plentiful that nearby eggs, white or brown, bring little premium over Western. Pack white shell together and label so, label others brown.

4. Good second-hand crates are very satisfactory and easy to get; they should, however, have good fillers. Many times fillers become flimsy and torn and cause much breakage in shipping. The covers of egg cases should not be nailed in the middle, but only at both ends. When a little excelsior or hay is placed in the bottom and on top, there is a certain amount of spring allowed which offsets many sudden jars.

5. Eggs should always be sent by express and the charges should be collected from the receiver. In this way he is in a better position to recover damages in case of breakage from the express company. It is very hard to recover anything on account of delays. It is a good plan to send the receiver a card by mail, notifying him of shipment.

6. In shipping to commission houses or egg jobbers, be sure that they are reliable. It is worth a great deal where possible for the prospective shipper to visit the market and by conversation and investigation, select his dealer. Having once decided on a firm, stick to them. If they are the right kind, buyers will soon be asking that receiver for your mark of eggs. Retail stores are very suspicious in buying eggs and are constantly trying to find a brand which is reliable. In this way a trade can be built up through your commission man which will yield several cents above the top market price.

6. SHIPPING DRESSED POULTRY.

Jersey broilers and Philadelphia capons are almost household words.

They bring the top prices in the markets and the producers know just how to grow and ship their products to suit the trade. Nevertheless there are many scrawny chickens and half-picked fowls sent to market which by expending two cents a pound on them before shipping would return four. The points which need especial attention in dressed poultry are outlined as follows:

First. Plump appearance.
Second. Correctly killed and picked.
Third. Carefully packed.
Fourth. Graded as to size and quality.
Fifth. Placed on market at right time.

1. It is often stated by market men that appearance sells goods more than quality. In dressed poultry we find that real quality nearly always presents a good appearance. A plump fowl will cook more tender and taste superior to a lean one any time. The extra fat seems to extend a gratifying influence throughout the carcass. The Jersey growers attain their best results when the broilers have some range and a liberal supply of good grain.

These "grain-fed" broilers have a firmer flesh and a better quality than do the "milk-fed" broilers from the middle west. There is hardly an excuse for sending scrawny chicks to market. There is always a wide difference between "poor" or "fair" quality and "fancy." At no time of the year ordinarily can a raiser lose by feeding as much cracked corn and wheat to his chicks as they will eat for two weeks before killing. Always remembering to stop feeding at least twenty-four hours preceding killing time. Old fowls do not pay to bother with much. However, good looking fat fowls usually bring several cents above common. With capons the grade is quite uniform. It seems that most people who raise them know how and they fatten up easily, and the best bring the top prices. Yellow skinned poultry is called for and is preferred in most markets.

2. All kinds of fowl should be bled and picked dry with the possible exception of young ducks in some markets. We see no more the headless chickens hanging in the store windows. The killing is all done by severing the jugular vein inside and at the back of the mouth. When this is done well, with the bird suspended head down, the blood is quickly and thoroughly drawn. Picking should commence immediately, plucking the feathers that come out hardest and the parts that tear easiest first. Each bird should be picked as soon as killed as the feathers set after the body cools and good picking then becomes impossible. Broilers, roasters and old fowls should be plucked clean down to within a few inches of the head. Capons should have the outer wing and tail feathers left as well as those about the neck.

3. Clean barrels serve admirable for any kind of dressed poultry. They should be lined with wrapping paper and after a couple of layers of poultry a layer of cracked ice should be added. In real warm weather a large piece of ice near the top keeps best, and in melting it passes down through the barrel, cooling off the entire contents. For real fancy broilers it may sometimes pay to pack one or two dozen in clean boxes. They may be "side packed," that is laid on their sides; or "back packed," laid on their backs. The main thing is uniformity and an inviting appearance. Wax paper can be used to advantage in wrapping the heads of each bird.

4. Where a number of fowls are to be sent to market there is an advantage in grading them according to size. Broilers less than one pound each are known as "squab broilers." Broilers from one

pound to one and one-half pounds are known as "small broilers." "Frying chickens" weighing from two and one-half pounds to three and one-half pounds are not in much demand. A few poor chickens mixed in with a lot of good ones are always detrimental to the lot.

5. A watch should be kept on the prevailing prices and the poultry sent in to market at the most propitious time. The smaller broilers sell best during the late winter and early spring months. Followed by best prices for larger broilers and roasters. Capons are in eager demand from the Holidays to Easter. Old fowls bring good prices during the two Jewish holiday seasons in the spring and the fall. It is often advisable to sell them alive at these seasons. The large Jewish population in New York City have a great influence over the live poultry market. Live poultry is shipped to New York every day in the year, but it is not sold there to any appreciable degree excepting on Thursdays and Fridays. This fact accounts for many sudden fluctuations of prices.

CONCLUSIONS.

The practical conclusions for the benefit of the actual producers seemed to be of especial significance.

1. That most of the causes of loss through shipping to distant markets may be corrected by the producer.

2. More attention should be paid to creating a demand and reputation for one's particular brand of products.

3. More attention should be given to the Poultry Industry by New Jersey farmers as a growing source of income, because of our unequaled situation in close proximity to the best markets in the country.

4. A closer study of the marketing end of the business, especially to supplying the demand for the high quality products.

5. Co-operation among the producers in isolated districts so they may gain the advantages of shipping in larger quantities and a more evenly distributed supply through the year.

The Poultry department is prepared to furnish to residents of the State desiring to co-operate in the marketing of their eggs an outline of an organization available to farmers and poultry raisers in a community whereby they may form a co-operative egg circle through which they can market their eggs collectively at a much higher price per dozen.

The following experiment which was one of a number of similar ones carried on last winter shows the attitude of the New York wholesale market with reference to care in marketing eggs.

The following shipments were made during the last week in February to a wholesale house in New York. The following table will describe the products and packages and also gives prices received for same:

No. 1. One ordinary light weight case mixed eggs, brown and white, not washed or sorted according to size. Price realized per dozen was $0.27.

No. 2. One heavy re-inforced crate with lock, eggs all brown in color, washed and assorted to size by eliminating all which were exceedingly small or large. Each dozen eggs was packed in guaranteed cartons. Price realized per dozen was $0.30.

No. 3. One heavy, re-inforced crate with lock; eggs all clear white in color, washed and assorted to size similar to crate No. 2. Each dozen eggs was packed in guaranteed cartons, as was crate No. 2. Price realized per dozen was $0.34.

The cartons in the above experiment cost $7.00 per thousand, and allowing one cent per dozen for time spent in sorting and packing and one-half cent for the extra cost of remodeling crate, we find an extra cost per dozen for improved method of marketing of $0.022. All the above allowances are very high, so that under average farm conditions it would be much lower.

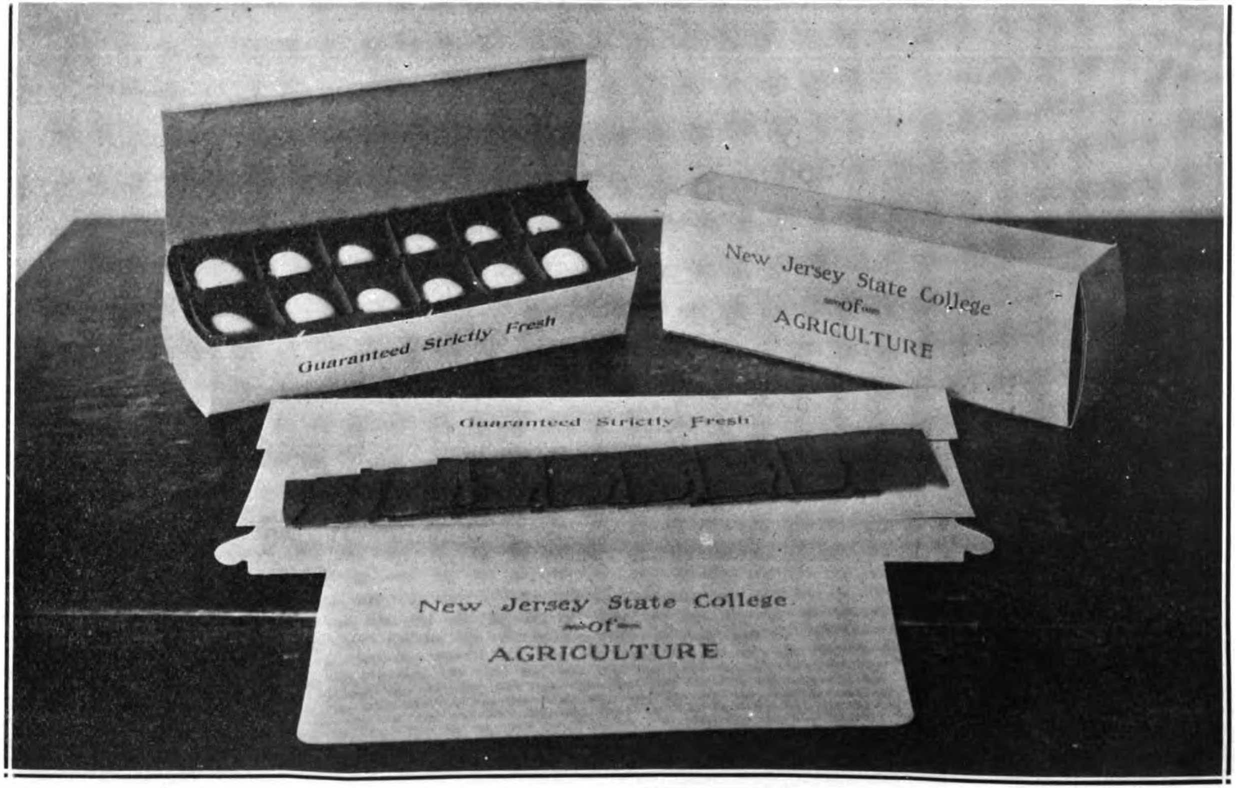
A small shipper, who markets two cases of eggs per week, would clear the following extra amount from his eggs if the above method of marketing was followed.

Two cases of eggs mixed, at $0.27, equals $16.20.

The same eggs sorted to size and color and washed would show the following values:

One case, browns, in individual cartons, at 30c. equals	$9 00
One case, whites, in individual cartons, at 34c. equals	10 20
Total	$19 20
Less $1.32 for increased cost leaves a balance of	17 88
Less value received for shipping in bulk	16 20
Total profits for improved methods (or three cents per dozen.)	$1 68

PLATE No. 21.

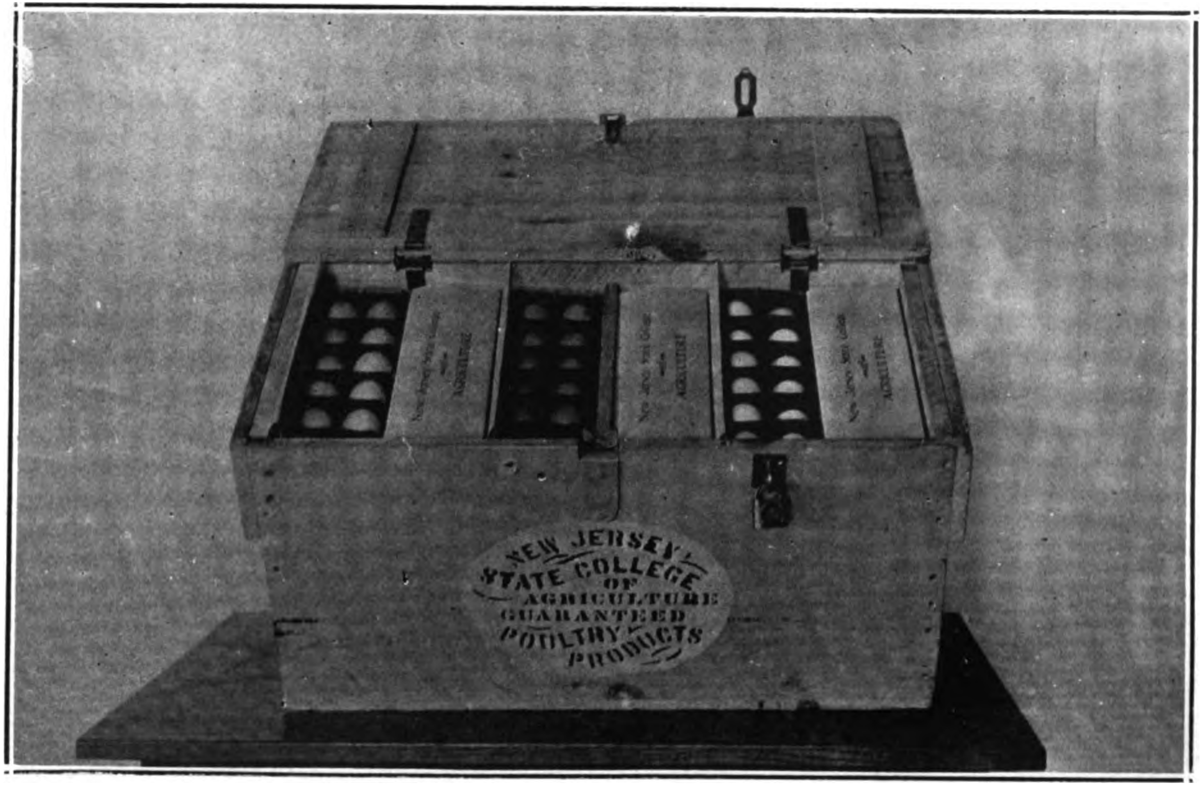


(A.)

Showing types of case and cartoons for which the increased price was paid.

UNIV. OF MICH.

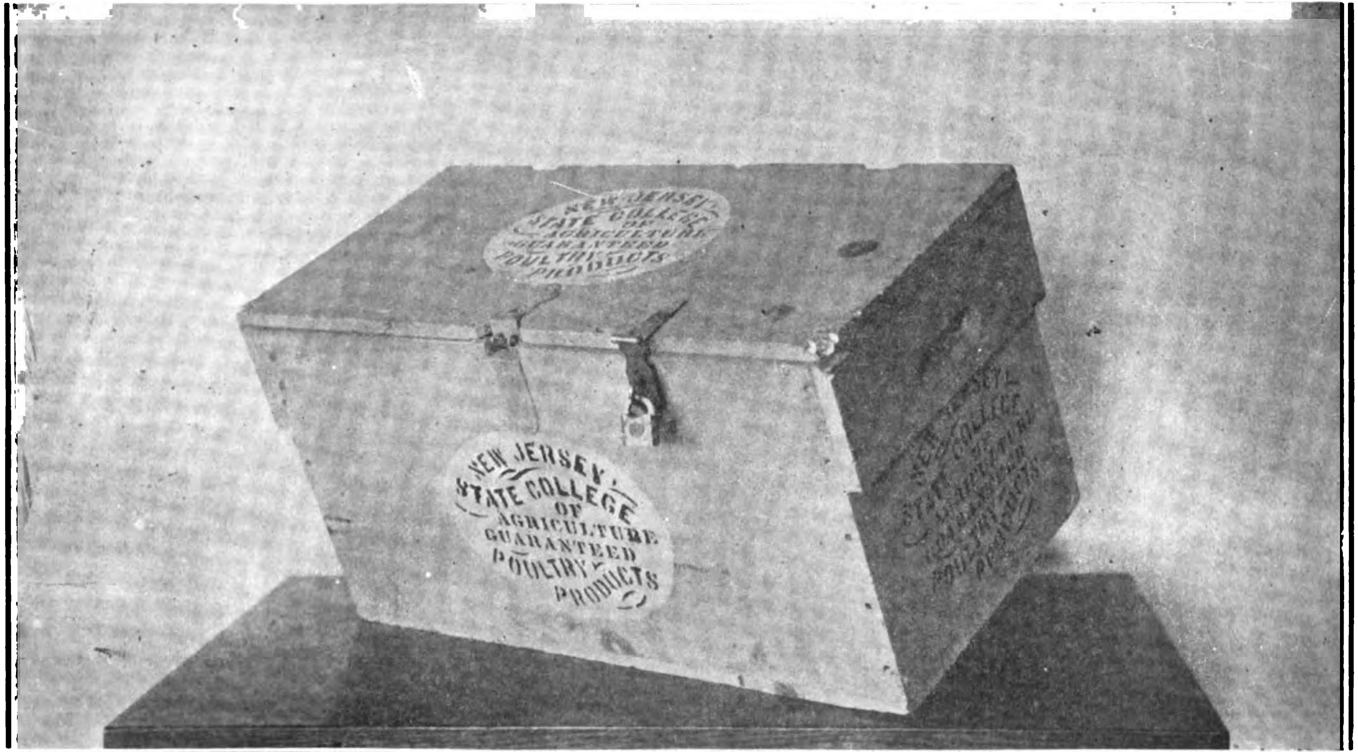
PLATE No. 21.



(B.)
Showing manner of packing cartoons in shipping care.

UNIV. OF MICH.

PLATE No. 21.



(C.)

Showing shipping case closed and locked.

This three cents would give to the shipper interest on the lower price of over eleven per cent. How could we better invest our time?

Always bear in mind that the extra price per dozen which is paid for appearance and quality is one hundred per cent. clear gain.

EXPERIMENT NO. 10.

A CONTINUOUS STUDY OF THE RELATIVE COST OF EGG PRODUCTION.

An attempt was made during the past year to make a careful study of the production and cost of the various breeds comprising the College flock, but owing to loss by fire of a number of the laying birds and the partial destruction of the houses, which made the total abandonment of the old plant necessary, combined with the fact that it was necessary to mix the breeds promiscuously owing to an insufficient number of pens, thus making the keeping of detailed, accurate records out of the question, it is, therefore, impossible to furnish complete data at this time.

This work will be continued each year, the idea being to study the individual as well as the breed in relation to profitable egg production.

The following figures give the total poultry egg yield, and the total number of mature females.

PLATE NO. 22.

	Eggs.	Mature Females.
December	614	282
January	1,694	267
February	1,358	240
March	2,834	200
April	3,144	200
May	2,299	190
June	1,920	165
July	1,312	130
August	1,085	61
September	604	60
October	491	60
November	419	51
	17,774	1,906

From this table it will be seen that the total production for the year was 17,774, or 1,481 dozen. This gives an average monthly yield of 1,481, or 123 dozen.

The average number of mature females throughout the year was 160, which gives an average yearly production per bird of 111, or 9.2 dozen.

The above figures are based upon a mixed flock, the inventory December 1st, 1910, showing the following breeds and numbers:

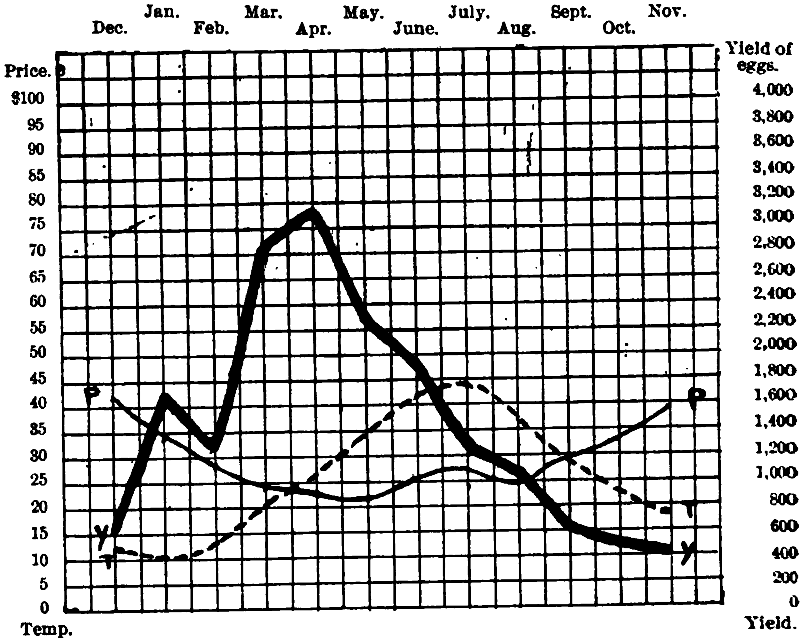
Barred Plymouth Rock Hens, mostly two and three years old	140
Barred Plymouth Rock Pullets	30
White Rock Hens	20
Black Minorca Hens	19
White Leghorn Hens	73
Total December 1, 1911	282

The majority of the birds in the above inventory were too old to make profitable egg producers, and were gradually disposed of for meat during the summer months; so that after August, 1911, the majority of the eggs laid were from March and April hatched pullets.

The following plate shows the year's egg yield plotted to a curve compared with the average monthly temperature, and selling price.

PLATE No. 23.

Curve showing relation between yield, temperature and selling price of eggs during the year 1911.



From the above it will be noted that production varies in direct ratio with the temperature conditions and that price being governed by production is influenced to a great extent by temperature conditions.

The above table will serve to call attention to the necessity, if the best price and a corresponding greater profit is to be realized, of using all possible care in methods of management to produce eggs during the winter months.

The following rations were used throughout the year with the variations in constituents to fit season and breed as outlined.

The following rations are especially adapted for the feeding of laying hens during the winter:

MIXTURE NO. 1.—DRY MASH.

Kind of food.	Lbs.	Protein.	Carbohydrates and Fat.	Cost.
Bran	200	24.0	92.0	$3 00
Middlings	200	25.0	116.0	3 06
Ground Oats	200	18.4	114.0	3 60
Corn Meal	100	6.3	71.0	1 42
Gluten	100	32.1	47.0	1 73
Meat Scraps	100	58.0	82.3	3 10
Alfalfa	100	14.3	48.2	2 20
Total	1,000	178.1	570.5	$18 11

Nutritive ratio equals 1 to 3.2.

Keep this mash always before the birds in self-feeding hoppers. During the molting period substitute oil meal for gluten in the same proportion to hasten the growth of feathers. When the birds are on green food, the alfalfa may be omitted, clover leaves may take its place at any time.

MIXTURE NO. 2.

Kind of food.	Lbs.	Protein.	Carbohydrates and Fat.	Cost.
Wheat	100	11.9	74.4	$2 05
Oats	100	9.2	57.0	1 80
Total	200	21.1	131.4	$3 85

Nutritive ratio, 1 to 6.2.

Feed in deep litter at 10 A. M. at the rate of five pounds to each 100 birds. This should be fed in a scratching shed or building where the litter is dry, and where the birds are protected from the cold winds.

The main function of this ration, besides the nutritive value, is to cause the birds to exercise.

MIXTURE No. 3.

Kind of food.	Lbs.	Protein.	Carbohydrates and Fat.	Cost.
Corn	200	12.6	142.0	$2 90
Wheat	100	11.9	74.4	2 05
Oats	100	9.2	57.0	1 80
Buckwheat	100	10.0	70.0	2 00
Total	500	43.7	343.4	$8 75

Nutritive ratio, 1 to 7.8.

Feed in deep litter at 4 P. M., 10 pounds to each 100 birds. The object of this feeding is mainly to give the birds a food suitable to furnish heat for the body during the night.

Twenty birds, or 100 pounds live weight, will receive, if fed the preceding ration, the following food nutrients per day.

Lbs.	Protein.	C. H. plus fat.	Cost.
8.0	1.1	4.87	$0 14

The nutritive ratio of the entire amount of food consumed per bird is 1 to 4.4.

The above ration, if fed carefully, costs 14 cents a day for 20 birds; one pound of protein costs 13 cents, and one pound of carbohydrates costs 3 cents.

It must be remembered in feeding that there is no best ration for all conditions, and that accurate amounts of any ration cannot be given before hand, but that the feeder must use his judgment, a good rule being to feed the birds all they will eat up quickly, at least, never to leave any lying around on the ground. One advantage of the dry mash in the above ration is that it allows each bird to balance its diet according to its own needs.

FUTURE EXPERIMENT WORK.

Numerous experiments of short duration dealing with the actual practice of care and management of poultry will be carried on in connection with the actual work of the plant. These will be largely of the nature of laboratory experiments, but the results will help to show the value and comparative efficiency of various methods now in use.

The main experimental work of a scientific as well as practical nature will be along the lines of poultry breeding, the following subjects being studied with the idea of proving or disproving some of the varying and disputed theories held to-day:

(*a*) Factors governing the inheritance of fecundity.
(*b*) The possibilities of continuous selected in-breeding.
(*c*) The Mendelian theory of inheritance especially as applied to color pattern in poultry.
(*d*) Correlation as an indication of egg production.
(*e*) The sex factors in its relation to color pattern in poultry. These lines of research will be laid out to continue over a period of from five to ten years or until the questions are solved.

Other lines of investigation will be as follows:

First. The factor of housing in relation to winter egg production.
Second. Succulent and forage crops for poultry feeding.
Third. Phosphorous as an ash constituent in the feeding of baby chicks.
Fourth. A systematic study of such poultry diseases which may come to the attention of the department.

EDUCATIONAL WORK.

There has been a constantly increasing demand from nearly every county in the State as well as from many granges, agricultural clubs and poultry associations for some systematic educational work along poultry lines; in some cases correspondence courses, while in others reading courses were requested. The following scheme of organization and study has therefore been outlined which began August 1st and will continue for one year, at which time it is hoped that funds will be available for the publication of regular reading course circulars, the systematic study of which will be carried on under the same organization, the number of circulars being large enough so that they will be available for free distribution in the State.

The objects of this organized educational work are twofold: *First.* To make available a systematic study of poultry husbandry to all poultry raisers in the State. *Second.* To provide a means of carrying the results of experiments, conducted during the year, directly to the poultry raisers in an educational way.

The reading course is not available to individuals, therefore, it is recommended that those wishing to take same, interest their friends and form a local organization.

This work has been very popular to date, and at present there are fourteen organizations representing seven counties in the State, taking the work. The membership in these associations range from ten to over five hundred. The total number reached by means of these fourteen organizations which are taking the work at present are 2,210. Five additional associations are planning to start the work January 1st.

This work is not designed in any way to act as a correspondence course, the Station doing nothing but furnish the outline of study, and recommending text-books for reference work, the idea being to simply get members to express their opinions and cite examples, thereby inducing discussion from which a greater amount of information can be obtained. It is by a free expression of opinion and discussion of same that the greatest benefit can be received.

OUTLINE OF POULTRY READING COURSE.

The following is the course outlined for 1911 and 1912, being a general discussion of the field in preparation of more detailed work to follow, if demanded:

August 2, 1911. **Basis and Beginning of the Business. Pages 9 to 27.** The poultryman's personality, basis and beginning advantages, and disadvantage, importance, purpose and plan of the business types of poultry keeping.

September 6, 1911. **Housing and Fencing. Pages 185 to 222.** Location, situation of plant, principles and practice of poultry house construction. Buildings necessary, yarding, method of construction, shade.

October 4, 1911. **Feeds and Feeding. Pages 107 to 132.** Nutrition, digestion, assimilation, feed stuffs, value and cost, feeding standards, balanced rations, practical rations, compounding rations.

November 1, 1911. **Exhibitions, Scoring and Judging. Pages 222 to 240.** Exhibiting, preparation, shipping care at show, scoring by card and comparison.

December 6, 1911. **Records, Accounts and Advertising. Pages 240 to 264.** Special poultry records, methods of keeping accounts, the business and practice of advertising.

January 3, 1912. Poultry Breeding. Pages 27 to 46. Principles and laws of breeding, practical applications of the principles, mating, etc.

February 7, 1912. Incubation. Pages 46 to 69. Formation of the egg, fertility, care of incubation eggs, development of the embryo, natural and artificial incubation, incubator cellar and running the machines.

March 6, 1912. Brooding. Pages 69 to 87. Vitality, care of young chicks, natural vs. artificial brooding, starting and running the brooder, feeding chicks.

April 3, 1912. Growing chicks. Pages 87 to 107. A detailed study of the care and feeding of broilers, roasters and capons, as well as the feeding and growing of pullets for layers.

May 1, 1912. Methods of Management. Pages 264 to 289. A discussion of all principles and practices of the care and management of poultry not discussed under special chapter.

June 5, 1912. Marketing Poultry and Poultry Products. A study of markets, methods of marketing, demand prices, manner of shipping to get best returns.

July 3, 1912. Parasites and Diseases. Pages 132 to 162. External parasites, internal parasites, common diseases, with symptoms, causes, prevention and treatment, method of diagnosis, clinical equipment necessary and advisability of treating sick birds.

Text book required, "Progressive Poultry Culture," by Arthur A. Brigham.

If possible each member of the association taking the work should own one of these books.

The following poultry books are very useful as reference and it should be the aim of every association to have at least one copy of each in its library:

Standard of Perfection, American Poultry Association.
Farm Poultry, Watson.
Poultry Craft, John H. Robinson.
How to Keep Hens for Profit, C. S. Valentine.
The New Egg Farm, H. H. Stoddard.
Poultry Architecture, Fiske.
Poultry Feeding and Fattening, Fiske.
Poultry Laboratory Guide, H. R. Lewis.
Diseases of Poultry, D. E. Salmon.
The Perfected Poultry of America, McGrew and Howard.

There are numerous breed and special books which will be recommended from time to time as well as many bulletins and circulars from other States which will be recommended at the time the lesson covered by same is up for discussion. The above books may be secured through this office at reduced prices.

The above outline covers the general topics in twelve lessons, one lesson each month, arranged so as to fit the season's work as near as possible. In this connection it may be said that the American Poultry Association has plans under way for the publication of Educational Bulletins which will aid greatly along this line, and it should be to the interest of every poultry raiser in the State to get in touch with the work of this Association and help make it a great utility as well as fancy organization.

In connection with the above course of study it should be planned to have lecturers from other sections of the State address some of the meetings; the Experiment Station and College will do as much of this as possible and members of the American Poultry Association will from time to time be available for the work. A list of review questions will be sent to the Secretary of each association the first of each month covering the lesson for that month and they can be used as a means of discussion bringing out the important points. A pleasant way to carry on the discussion is to give each member a slip of paper at the beginning of the meeting, containing the question he is to discuss, and after he has covered the work in the text a few minutes may be left for general discussion of the same before taking up the next question in order and so on.

The following Constitution and By-Laws are recommended to be adopted when forming a County Association. This is recommended for two reasons:

First. To have all organizations uniform.

Second. To have the Constitution broad enough to admit of a wide field of endeavor, should condition warrant.

The following form has been adopted by four county bodies to date:

CONSTITUTION AND BY-LAWS

FOR

COUNTY POULTRY ASSOCIATIONS

NEW JERSEY.

CONSTITUTION.

ARTICLE 1.

This Association, formed by the poultry raisers of   County, shall be known as the   County Association.

ARTICLE 2.

Its object shall be to discuss all topics affecting the progress and prosperity of its members as poultrymen, and to promote a knowledge of practical poultry culture.

ARTICLE 3.

Any person interested in the object of this Association may become an Active Member by a vote of two-thirds of the members present at any regular meeting, and the payment of One Dollar, provided such person has been proposed at the previous meeting.

ARTICLE 4.

The officers shall consist of a President, Vice President, Secretary, Treasurer, Librarian and a Board of Directors, consisting of eight members, of whom the officers shall be five; and shall be elected by ballot at the annual meeting on the first Wednesday in February in each year, and shall hold office for one year or until their successors shall be elected; and in case of the death. resignation or removal from the County of any such officer, the Board of Directors shall, by appointment. fill the vacancy so occasioned, subject to the approval of the Association at the next meeting following such an appointment.

ARTICLE 5.

The President shall perform the duties usually devolving on the presiding officer of a deliberative body. In his absence the Vice President shall preside. In the absence of both, a chairman pro tem. shall be chosen.

ARTICLE 6.

The Secretary shall take minutes of the proceedings at all meetings, and read them at the next regular meeting, and when approved record them in a journal. He shall keep a correct roll of the members, notify them of their election to office. and of their appointment on committees, shall give notice of their election to all admitted to membership in the Association, shall issue notices of special meetings, conduct the correspondence of this Association, and perform all other duties incident to his office.

ARTICLE 7.

The Librarian shall have charge and custody of the Association's Library, shall keep a correct list of all books thereto belonging. shall give out the same to members of the Association upon application, and shall collect them back into the Library at the expiration of the time allowed by the Association. He shall at the close of each official year, make out and present to the Association a summarized report of the use and condition of the Library during the year. He shall also collect a fee of ten cents per month from each member for each book borrowed and shall spend money so collected for the upkeep of the Library.

ARTICLE 8.

It shall be the duty of the Treasurer to collect all dues from the members, receive and hold in trust all moneys belonging to the Association, and to pay out the same when so ordered by a vote of the Association. He shall at the end of every fiscal year, make a written summarized report to the Association of all moneys received and disbursed by him, and the amounts due and unpaid.

ARTICLE 9.

The Board of Directors shall have a general supervision and the carrying out of the objects of the Association, arrange subjects for discussion at its regular meetings, invite members and others to address the Association, and ascertain whether it will be for the interest of members to make sales and purchases. Three shall constitute a quorum, and the Directors shall make a full report to the Association at every annual meeting through the Secretary.

ARTICLE 10.

This Constitution cannot be altered or amended except at an annual meeting with the concurrence of two-thirds of the members present, and then only when the proposed alteration has been submitted to the Association at a previous meeting.

BY-LAWS.

ARTICLE 1.

The stated meetings of the Association shall be held in the County Court House on the first Wednesday of each month, at 8 o'clock P. M., unless otherwise ordered by a vote of the majority of the members present at a previous meeting.

ARTICLE 2.

Five members shall constitute a quorum to transact business.

ARTICLE 3.

The order of business at stated meetings shall be as follows:

1. Roll call.
2. Reading of minutes of previous meeting.
3. Report of Executive Committee.
4. Reports of Special Committees.
5. Proposal of members and election of new members.
6. Miscellaneous business.
7. Reading of papers. discussion and addresses.
8. Announcement of Board of Directors of special subject for discussion at next meeting, and appointment by the President of the members to lead in such discussion.

ARTICLE 4.

No person shall speak more than ten minutes upon any subject under consideration unless by invitation or consent of the Association, and it shall be the duty of the chairman to call any member to order when this rule is violated.

ARTICLE 5.

Members not complying with the provisions of the Constitution and By-Laws may be expelled at any regular meeting by a vote of two-thirds of the members present.

ARTICLE 6.

These By-Laws may be amended at any regular meeting of the Association. provided the proposed amendment shall have been presented at the previous meeting.

PART TWO.

DETAILS PERTAINING TO THE NEW STATION POULTRY PLANT.

The funds made available by State appropriation during the last session of the State Legislature have made possible the erection and equipping of a complete poultry plant for experimental work along poultry lines. The following data with reference to the plant treats of the work already completed, and gives details of soil, plan of plant and design and construction of poultry houses in complete form so that the facts may be referred to in later publications.

LOCATION AND SITE.

The plant is located on land belonging to Rutgers College, which was set aside by special action of the Board of Trustees for that purpose. This piece of land is a part of The College Farm, containing 5.7 acres, with a 500 foot front on Nichol avenue and a depth of 500 feet. This location is very desirable from the fact that the ground is high, giving excellent surface drainage, the land having a general slope to the southeast. The site is entirely lacking in natural shade, same is to be immediately provided by the planting of peach trees and the use of corn and sunflowers until the trees develop enough to furnish the necessary amount.

THE SOIL.

The soil conditions are the poorest which could possibly be found in the State for the raising of poultry, being a heavy red shale, through which water leaches slowly and which becomes very soft and pasty with the least rainfall, drying out very slowly. This soil packs quickly, and is very hard, forming a surface crust, through which it is impossible to break readily during dry weather, offering very little chance for the birds to find natural dusting places, and requiring a lot of labor in keeping the runs clean and sweet.

The character of the soil is very objectionable from the fancier's standpoint as it is impossible to allow show birds on an outdoor run without ruining the plumage. The soil is fertile, being especially suited to the growing of luxuriant green crops for forage.

PREVIOUS HISTORY OF LAND.

The land has been heavily manured and cropped for the past five years, corn, peas and oats and garden crops predominating. Three acres on the southeast side are covered with a heavy seeding of three-year-old alfalfa. This area will be closely yarded and grazed successively in an attempt to determine the actual value of alfalfa as a crop to be eaten by the birds directly from the root. Special study being made to determine—

(*a*) The most desirable length of periods; without injuring the future growth.

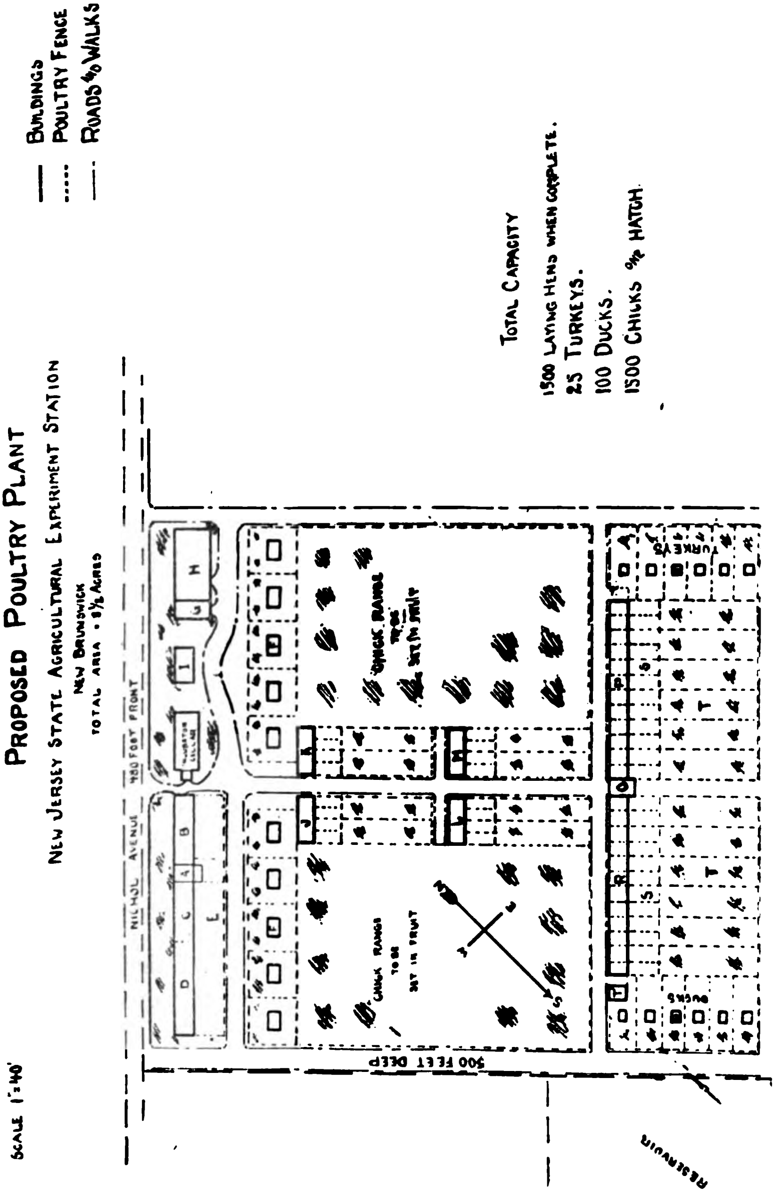
(*b*) The desired height for most economical feeding.

PLAN OF THE PLANT.

The plan is laid out on an intensive basis due to the small amount of land available and the high valuable of same. Most of the laying houses are the continuous type, designed to illustrate different types of construction.

The following plate shows general plan of the plant and t accompanying key explains same briefly:

PLATE No. 24.



A.—Boiler room and cellar for sprouting oats, to supply heat for brooder houses B., C. and for incubator cellar.

B.—Brooder house equipped with universal hovers.

C.—Nursery brooders with over-head heat from pipe runs.

D.—Brooder room equipped with the Hall system of hovers and heating.

E.—Brooder runs to be low and covered.

F.—Individual outdoor brooders, kerosene and gasoline.

G.—Single story addition attached to the administration building (H) to be used for the study of poultry diseases. A hospital, operating room and microscopic laboratory.

H.—General administration building having the following rooms for various purposes. Outside, 30 x 60 feet.

Basement; Boiler room, feed room, egg candling, packing and storage room. bed room and toilet.

Second floor; Office, library, large room for demonstration work, before farmers' meeting, and for experiments in mating.

I.—Building for experiments in crate and machine fattening. To be of simple construction.

J, K, L, M.—Laying houses, 40 x 16 feet, to be constructed by Short Course students.

N.—Turkey shelters.

O.—Small feed and work room in center of long laying houses.

P.—Laying house 150 feet long to be 16 feet wide, shed roof with no alley. Open front.

R.—Laying houses 150 feet long to be open front, glass and wood. 16 feet wide.

S.—Small exercise yards, one for each separate pen.

T.—Large feeding yards for a two-yard double unit, park system of yarding.

U.—Duck houses.

t.—Manure pit.

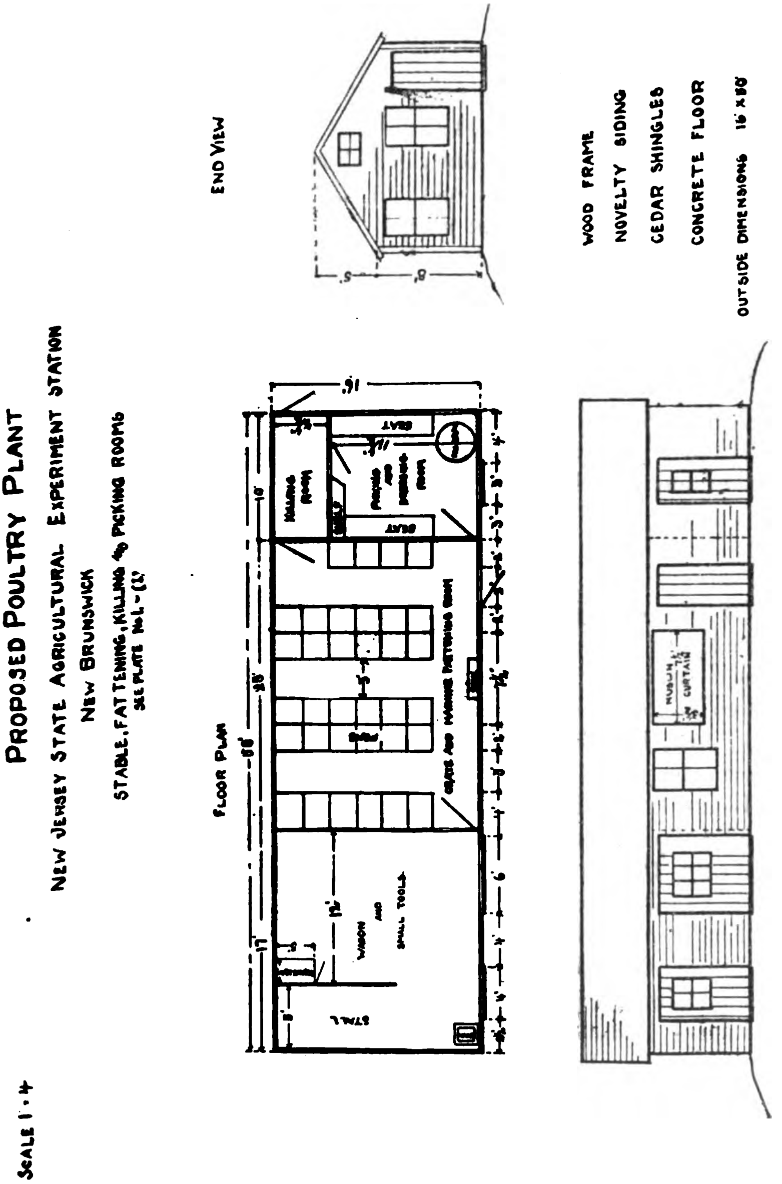
At this writing the Administration Building and Hospital (H and G) are approaching completion and will be ready for occupancy on Dec. 15th, two weeks before the date called for in the contract.

This building and addition is constructed of Dennison Hollow Tile throughout, and is finished on the exterior with Stucco, float finish. The entire building, including hospital addition, is 75 x 30 feet, the latter being 30 x 15 feet, the main part (H) is two stories in height, surmounted by a gentle sloping roof with heavy bracketed overhang, giving a bungalow effect.

This building will cost when completed, approximately, $7,500.

The fattening and killing house (1) is 16 x 50 feet and the details are shown in Plate 25.

PLATE No. 25.



This building is designed especially for the carrying on of experiments in crate vs. machine fattening and in experimenting with the various methods of killing and dressing poultry.

The stable and tool room has been omitted and a completely equipped work shop installed in its place.

INCUBATOR CELLAR AND BROODER HOUSE.

These buildings are nearing completion and will be ready for use about January 1st, 1912.

The incubator cellar is built of hollow tile, stuccoed, it is 20 x 50 feet, with nine feet head room to the plate, of which five feet is below the ground and four above.

The brooder houses are each 50 x 16 feet with boiler room in the center. They are designed to be equipped with indoor brooders and are of the depressed alley type. Both houses will have a combined capacity of 1,000 chicks to ten weeks of age.

The complete description of these buildings together with plans and photographs are omitted at this time as they will be published later, in a separate cover, on work dealing with Artificial Incubation and Brooding.

LAYING HOUSES.

Of the four type houses, J, K, L and M, J and K are completed and will be described in detail in the following pages. House M is at present under construction and is being built of Natco Hollow Tile, plastered both sides. It is 16 x 40 feet with shed roof, five feet high in back and eight in front, with muslin front.

House L is to be 20 x 40 feet with a shed roof and curtain front.

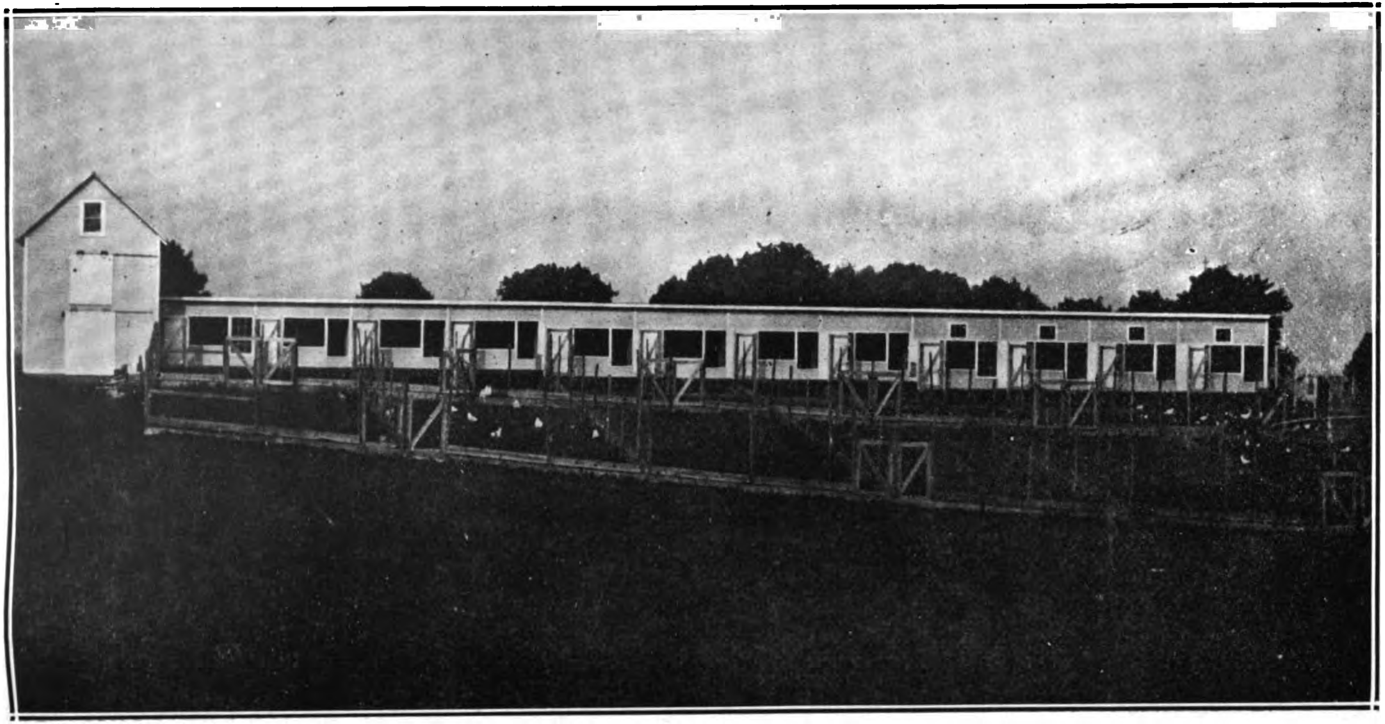
The feed house at (0) is complete and consists of a two-story building, 16 feet to the plate, with a loft for storage. The lower floor contains grain bins, caldrons and feeding utensils.

The floor is of concrete and the walls are filled between outer and inner sheathing with concrete to a height of three feet, making the building rat proof.

Laying house (P) is completed and represents a typical long house of the shed roof type, being 16 x 144 feet, divided into twelve pens each 16 x 12 feet.

This house is built in three sections each 48 feet long with a solid partition between each section. In showing plan and giving material for same, one section only will be considered.

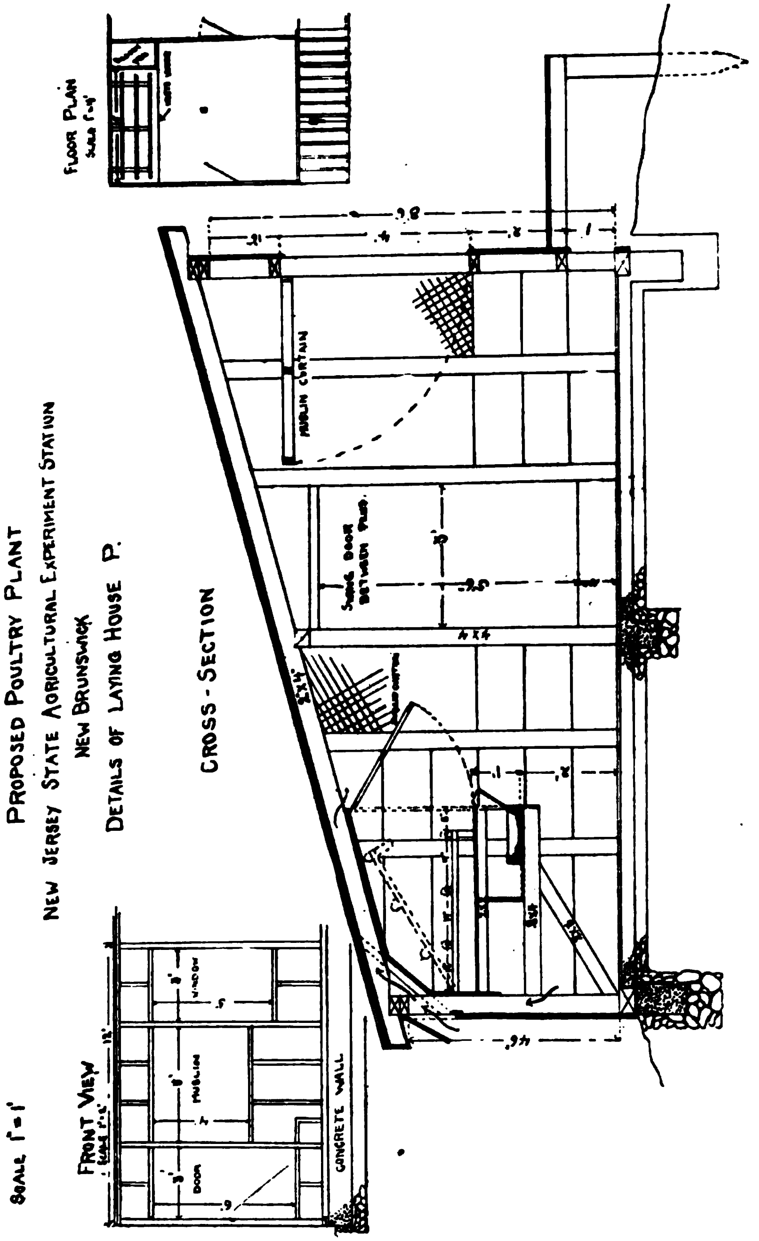
PLATE No. 27.



Exterior view of N. J. State Curtain Front House.

The following plate shows the plan of the cross section as well as the framing of the front wall.

PLATE No. 26.



It will be noticed that a door is shown in the front of each pen, this is necessary in a house to be used for educational and experimental work, but is not desirable in a farm poultry house where one attendant will care for the entire flock. The muslin curtain should be extended to cover this space.

Attention is called to the presence of an elevated walk in front of the house, to allow easy access to each pen and yet allow the birds to enter the yards which extend to the south or front side.

Note the hinged clapboard on the outside of the back wall which can be opened and thus allow air to circulate around the perches on hot summer nights.

The following list of material is required to build a section of this type 16 x 48 feet:

MATERIALS FOR N. J. STATE CURTAIN FRONT HOUSE.

Foundation, 2 feet deep and 8 in. wide; 20 bags cement; 2 cu. yds. gravel; 6 cu. yds. cinders. All framing material hemlock or yellow pine.

Sills—		
	8—2 x 6 x 20.	**Doubled.**
	8—2 x 6 x 16.	
	3—2 x 4 x 16.	
End and division studs—		
	10—2 x 4 x 8.	
	5—2 x 4 x 7.	
	10—2 x 4 x 6.	
	10—2 x 4 x 7—Doubled, for doors to hinge on.	
Side wall studs—		
	36—2 x 4 x 8½.	
	23—2 x 4 x 5½.	
Extras for short pieces—		
	3—2 x 4 x 12.	
Corner and division posts (doubled)—		
	18—2 x 4 x 8½.	
	10—2 x 4 x 5½.	
Rafters—		
	25—2 x 4 x 18.	
Girder (doubled)—		
	4—2 x 4 x 20.	
	2—2 x 4 x 8.	

Plates—
8—2 x 4 x 20.
4—2 x 4 x 8.
Roof boards, 900 sq. ft. ship-lap.
Roof paper, 900 sq. ft.
Supports for dropping boards, &c—
32—2 x 3 x 4.
20—2 x 4 x 3.
Perches—
12—2 x 2 x 10.
700 sq. ft. ship-lap for inside back sheathing, dropping boards, partitions, &c.
250 linear ft. shingle lath for nest platform.
Siding—550 sq. ft. novelty siding; 4 cloth curtains, 4 x 5; 4 window sash, 5 x 3.
Trimming, doors, nests, &c.—
200 linear ft., 1 x 2 dressed W. Pine.
100 linear ft., 1 x 3 dressed W. Pine.
500 linear ft., 1 x 4 dressed W. Pine.
200 square ft., 1 x 8 dressed W. Pine. Matched.
3 prs. double swing butts.
5 prs. 5-inch strap hinges for doors.
12 prs. 4-inch strap hinges for windows and curtains and small doors.
5 barn door latches.

This material will cost approximately $217.00 or for 48 linear feet will give a cost of $4.52 per running foot or $0.28 per sq. ft. for the area of 768 sq. ft., which, when allowing 4 sq. ft. per bird, makes the cost per bird $1.12.

Type houses (J) is completed and represents the extreme in open front type. Plate 28 shows details of construction and dimensions.

PLATE No. 28.

Type House (J).

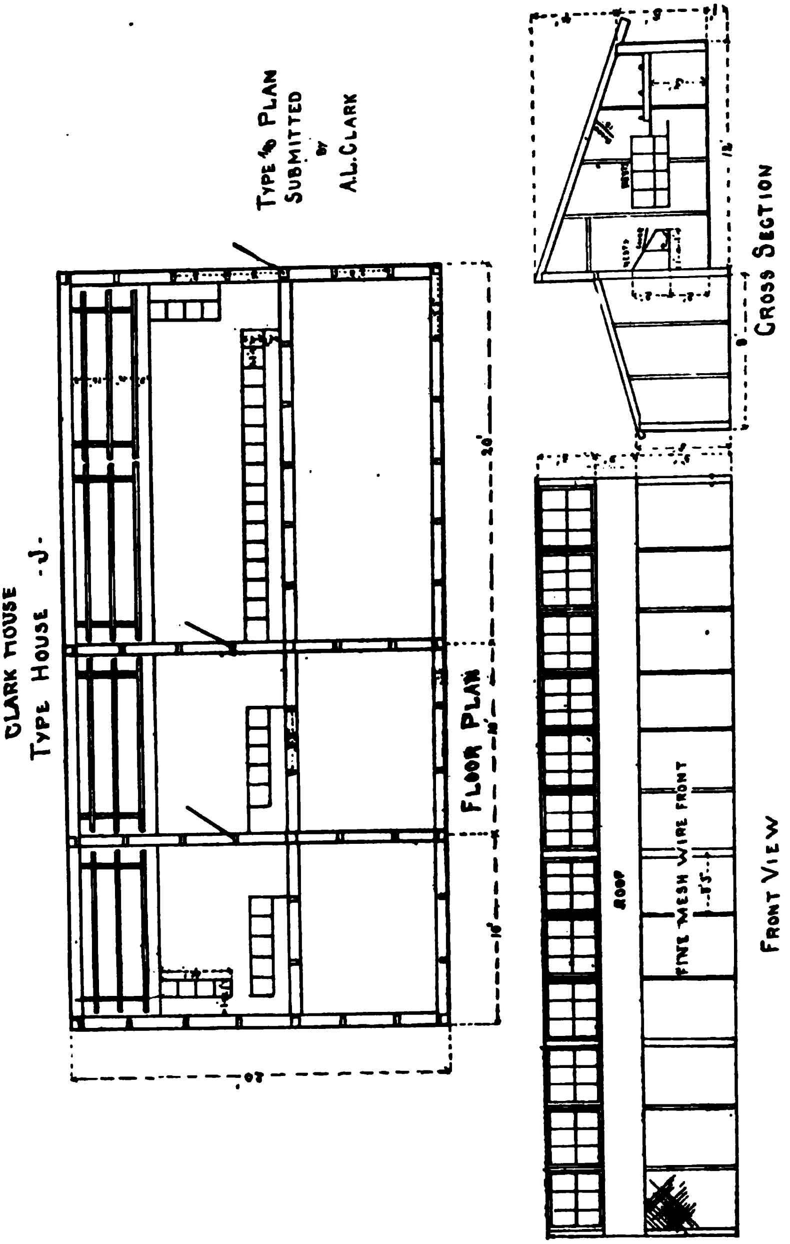
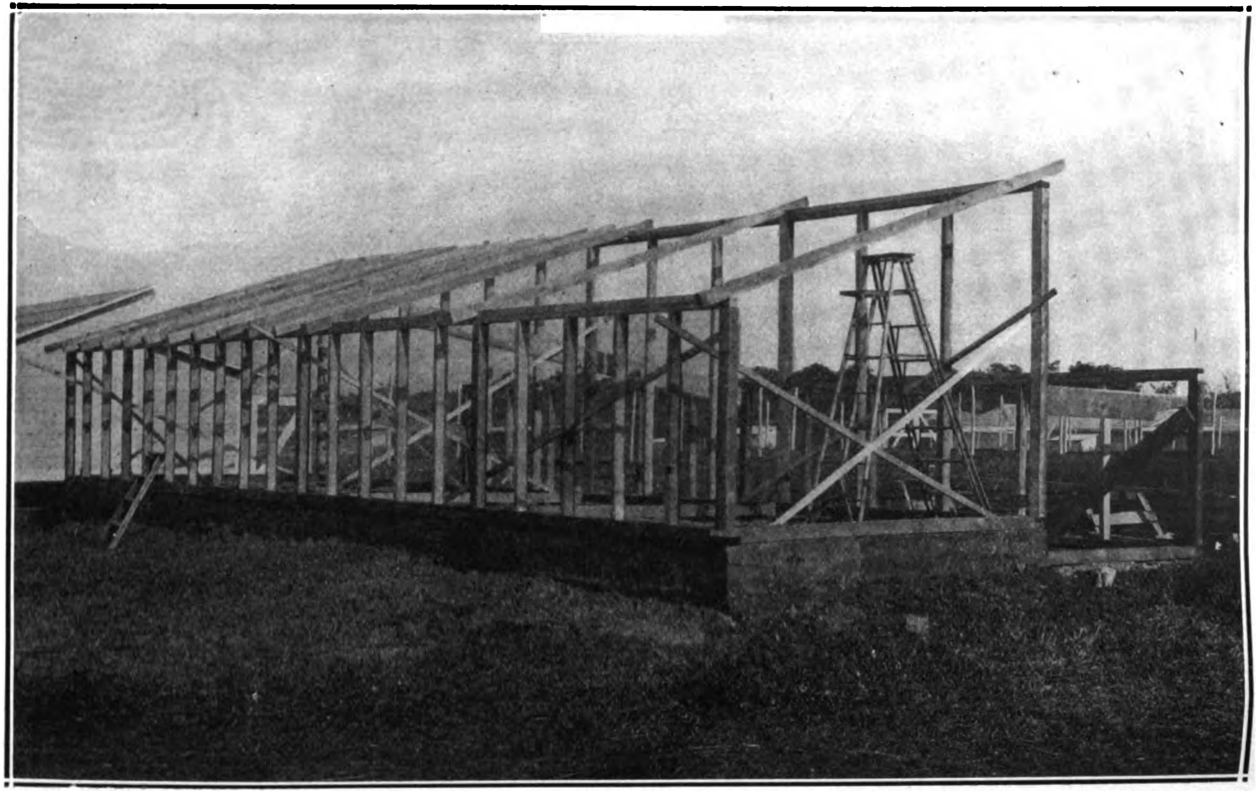
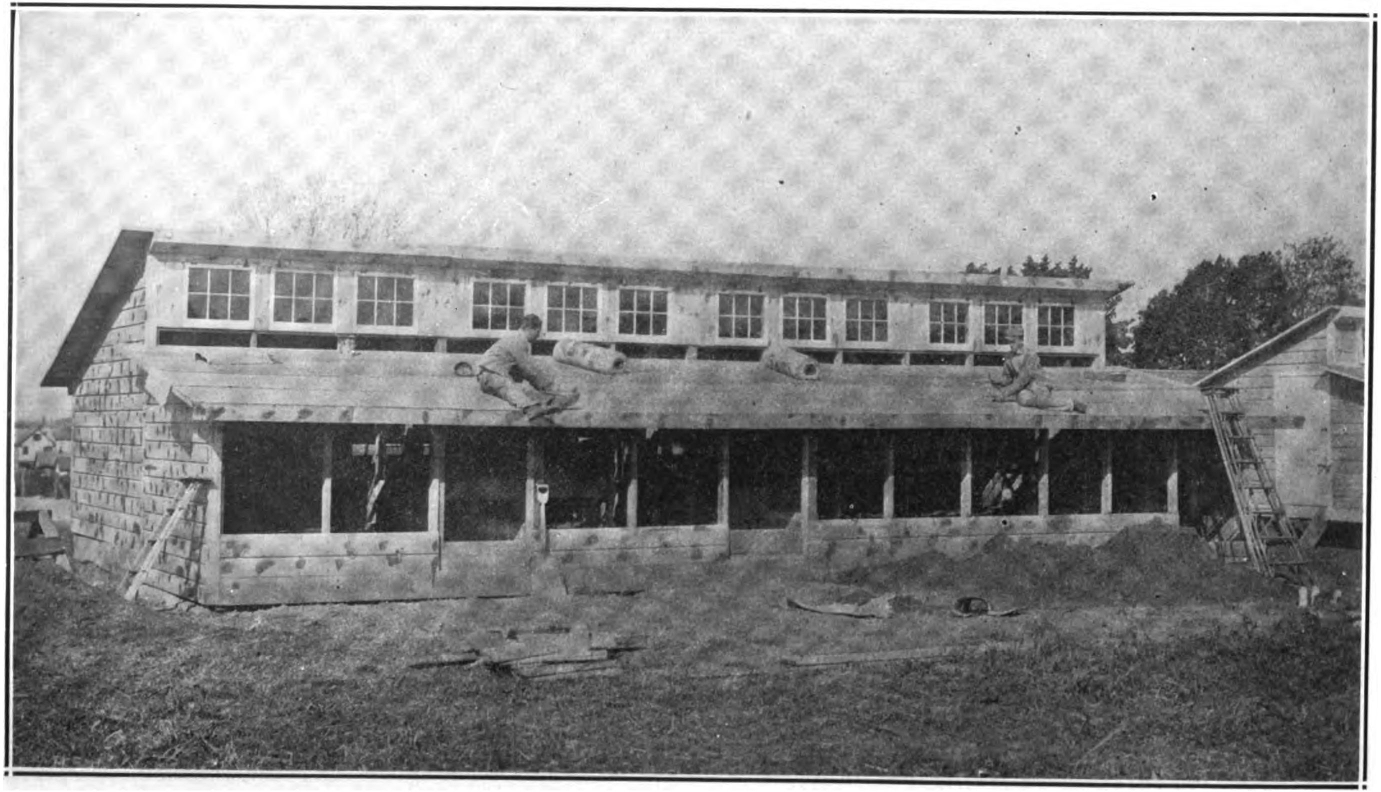


PLATE No. 29.



(A.)
Showing foundation and frame of Type House (J).

PLATE No. 29.



(B.)

Showing Type House (J) nearly completed. Note open front and glass in peak.

This house is of the half monitor type, with an entire glass front in the peak, and the shed roof extension, left entirely open two feet above the ground and covered with small mesh poultry netting, no curtains being provided to cover same. The nests and perches are in the back part of the house and are protected and separated from the open front by a solid board partition extending from the lower part of the windows to within two feet of the floor. The windows in the peak are equipped with transom, so that they may be opened, being hinged at the top and opening outward.

The following is a list of material required for type house (J) complete:

LIST OF MATERIAL. TYPE HOUSE (J).

Foundation, concrete wall as deep as necessary and 8 in. wide, 22 bags cement, 2 cu. yds. gravel, 4 cu. yds. cinders.

Sills—
12—2 x 6 x 20.
4—2 x 6 x 12. } Doubled.
4—2 x 6 x 8.

Corner and division posts. 2 x 4S doubled—
16—2 x 4 x 5.
8—2 x 4 x 9.

End wall and division studs—
6—2 x 4 x 6.
12—2 x 4 x 8.

Side wall studs and long partition—
28—2 x 4 x 5.
9—2 x 4 x 9.

Plates—
8—2 x 4 x 20.

Girder, sill under windows—
2—2 x 4 x 20.

Rafters—
21—2 x 4 x 14.
21—2 x 4 x 10.

Extra pieces for window work, droppings, boards, &c.—
10—2 x 4 x 12.

Supports for dropping boards—
12—2 x 4 x 10.

Perches—
16—2 x 2 x 10.

720 sq. ft. ship-lap for partitions, nests and dropping boards.
1,000 sq. ft. ship-lap for roof.
1,000 sq. ft. roofing paper.
12 sash, 34 x 34.

Trimming—
50 linear ft., 1 x 2 dressed W. Pine.
150 linear ft., 1 x 3 dressed W. Pine.
80 linear ft., 1 x 4 dressed W. Pine.
120 linear ft., 1 x 6 dressed W. Pine.

This material will cost approximately $219.50 or 40 linear feet will give a cost of $5.48 per running foot or $0.27 per sq. ft. for the total area of 800 sq. ft., which, when allowing 4 sq. ft. per bird makes the cost per bird $1.08, not including labor.

Amatite paper was used on type house (J).

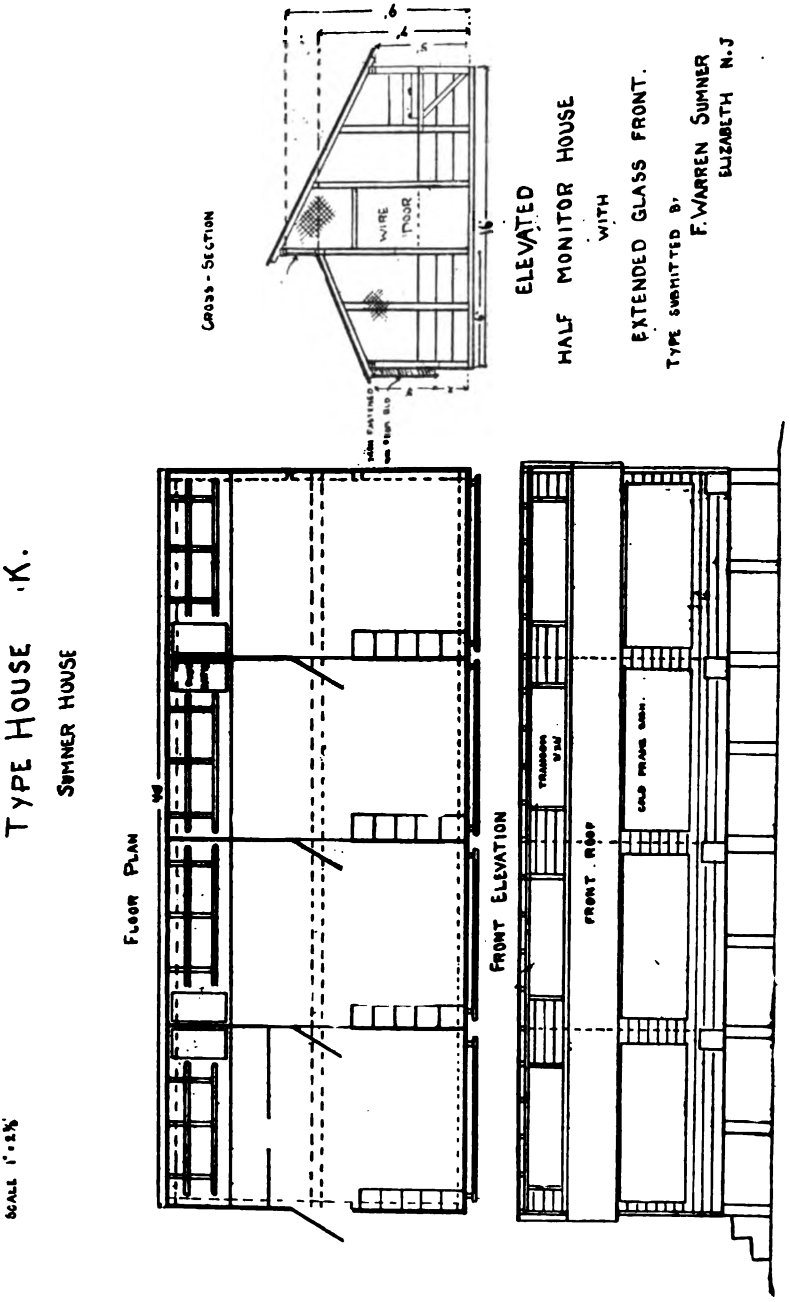
Plate 29 shows two views of this house while under construction.

Type house (K) is complete and represents a closed house with no muslin curtains. It is of the half monitor type, 16 x 40 ft., raised two feet from the ground with a double board floor and paper between.

Plate 30 shows design and dimension of type house (K).

PLATE No. 30.

Plan of Type House (K).



The house is supported on cedar posts, two feet high, every eight feet; the back and end being closed in to stop drafts and storms from sweeping under the house.

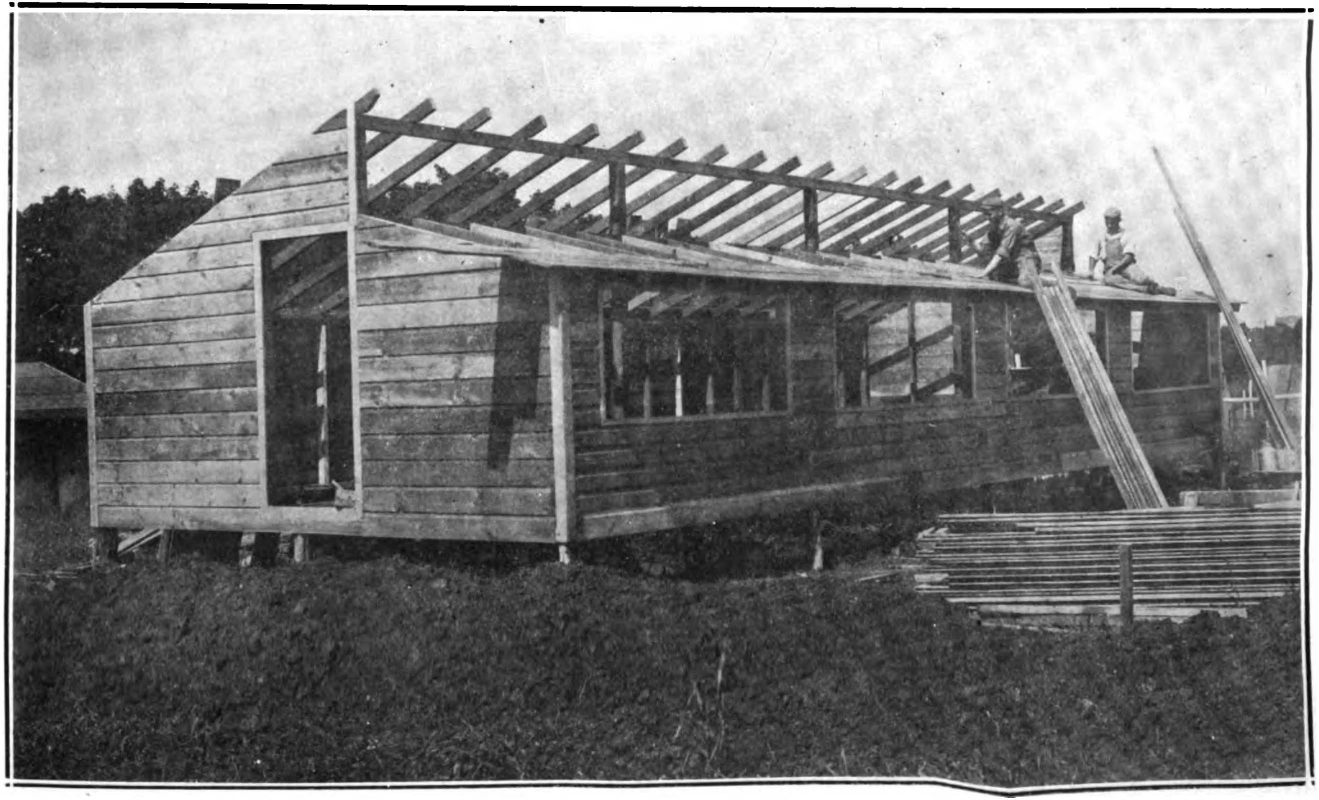
The dropping boards and perches are arranged along the back. The four openings in the peak are equipped with large glass, sash, hinges at the top and opening out.

The four lower openings are covered with an extended glass front, placed four inches from the building, leaving an open space at top and bottom for circulation.

The following is a list of material required for type house (K):

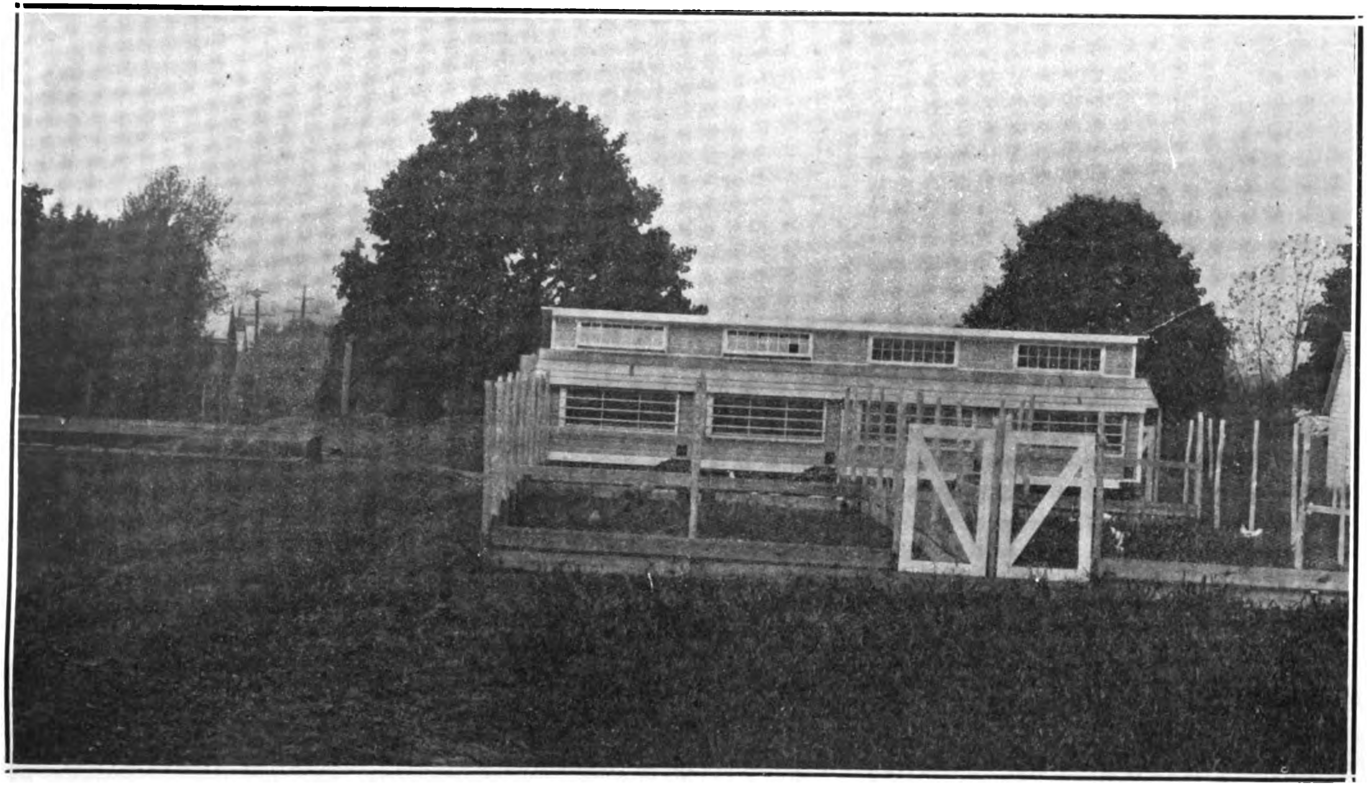
Foundation, 15 cedar posts, 4 to 6 inches in diameter, 4 in. long.
Floor girder—
4—2 x 4 x 20.
Floor joists—
21—2 x 6 x 16.
Sills—
8—2 x 6 x 20.
4—2 x 6 x 16.
Corner and division posts to be of 2 x 4, double—
20—2 x 4 x 5.
10—2 x 4 x 10.
Side wall studs—
19—2 x 4 x 5.
12—2 x 4 x 2.
End wall and inside division studs—
5—2 x 4 x 10.
10—2 x 4 x 7.
Plates—
12—2 x 4 x 20.
Overhead girder—
4—2 x 4 x 20.
Rafters—
21—2 x 4 x 12.
1—2 x 4 x 7.
Roof boards, 800 sq. ft. ship-lap.
Siding, 700 sq. ft. novelty siding.
Floor—First, 500 sq. ft. hemlock, rough; second, 500 sq. ft. ship-lap.
Droppings, boards and inside partitions and nests, 500 sq. ft. ship-lap.
Perches—
8—2 x 2 x 8.
Short pieces, incidentals, &c.—
15—2 x 4 x 16.
Roofing paper, 800 sq. ft.
Windows, 4 hot-bed sash, 8 x 3; (for above) 16 lag screws, 3 in. long. 4 sash, 16 x 2, single. 2 sash, 24 x 28, double.
Trimming—
100 linear ft., 1 x 3 dressed W. Pine.
100 linear ft., 1 x 2 dressed W. Pine.
50 linear ft., 1 x 4 dressed W. Pine.
120 linear ft., 1 x 5 dressed W. Pine.
40 linear ft., 1 x 8 dressed W. Pine.
Hardware—3 pieces double swing belts. 5½ pieces double strap hinges. 1 B. D. latch.

PLATE No. 31.



(A.)
Type House (K) partially completed.

PLATE No. 31.



(B.)

Type House (K) complete with yards.

The above material, complete, cost $206.45, which equals $5.15 per running foot, or considering the total square feet of floor space, 640, makes one square foot cost $0.31, or allowing four square feet per bird, the cost per bird is $1.24.

The details of the houses to be built and those not included in the above will be published at a future date. From time to time the conditions, as egg yield, temperature, &c., as they are found in the different houses will be given and recommendations made as to the most desirable type.

REPORT OF THE SOIL CHEMIST AND BACTERIOLOGIST.

REPORT OF THE SOIL CHEMIST AND BACTERIOLOGIST.

JACOB G. LIPMAN.
AUGUSTINE W. BLAIR.
IRVING L. OWEN.
HARRY C. MCLEAN.

THE AVAILABILITY OF NITROGENOUS MATERIALS AS MEASURED BY AMMONIFICATION.

II.

Both external and internal conditions influence the decomposition of organic substances. The former include moisture and temperature relations, as well as the chemical and mechanical make-up of the medium. The latter pertain to the chemical and physical structure of the decaying substance and to the character of the micro-organisms prominent in the decomposition process.

As was shown in an earlier communication on this subject[1] the external conditions may be made uniform and the internal conditions so controlled as to allow a satisfactory comparison of the *availabilities* of different materials—that is, of the rates at which they will decompose under given uniform conditions. Such comparisons are of value in the investigation of decay processes in cultivated soils. They also find a practical application in the examination of commercial fertilizers derived partly or wholly from vegetable or animal sources.

The experiments of 1909-1910[2] made it clear that there is a wide range of availability among commercial samples of dried blood, tankage, fish, &c. The same condition was found to apply to mixed fertilizers. It seemed desirable, therefore, to broaden the scope of the inquiry and to secure additional data on the value of the method employed. The experiments reported in the following pages constitute such additional data.

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[1] Centralblatt für Bakt., &c., II Abt., Vol. 31, (1911), p. 49.
[2] l. c.

AMMONIA FORMATION FROM DRIED BLOOD AND TANKAGE.

Series A.

The soil employed in this series was a mixture of heavy, silt loam and sand. An amount of organic material equivalent to 155 mgs. of nitrogen was weighed into tumblers containing the soil mixture (80 grams air dry soil, 20 grams sand) and 0.5 gram calcium carbonate. Eighteen cc. of water (including 6 cc. of soil infusion) was added for the soil mixture, and 60 per cent. moisture was added for the organic matter. In each case the mixture of soil, sand and calcium carbonate was placed in a tumbler, the required amount of dried blood added and thoroughly mixed with the other materials, and the whole moistened as indicated. The tumblers were covered and kept in the incubator at 27°–28° C. for periods of four and seven days. At the end of these periods the ammonia was distilled into standard acid and the distillate titrated in the usual manner.

The arrangement of the series and the amount of ammonia nitrogen recovered are indicated in the following table.

A study of the table shows that the concentrated tankage yielded the highest percentage of ammonia nitrogen. It is further to be noted that during the four-day period none of the blood samples yielded as much ammonia nitrogen as the lowest yield from the tankage samples. The average of all tankage samples for this period is 60.86 mgs., while the average for all the blood samples is 26.47 mgs. The average increase over check during the four-day period for the tankage is 57.85 mgs., and for the blood it is 23.14 mgs.

It is to be noted that in most cases the blood samples became available less rapidly than the tankage. For example, from blood sample E there was recovered in four days 9.56% of the nitrogen, and in seven days 24.43%, while from the concentrated tankage there was recovered in four days 53.09%, and in seven days 58.41%; a much smaller gain for the last three days than there was with the dried blood.

There is, also, a difference in the rate of availability of the same materials. For example, from tankage A there was recovered in four days 32.84%, and in seven days 37.20%, while with tankage L there was recovered in four days only 28.96%, and in seven days 41.60%. As an explanation of the more rapid availability of tankage than of blood it has been suggested that possibly in the drying process the blood becomes slightly charred, so that there is a hard coating about the surface.

SOIL PORTION NO.	Material Added.	Water Added.	AMMONIA N. FOUND.				AVERAGE INCREASE OVER CHECK.		PER CENT. NITROGEN RECOVERED.	
			4 Days.	Average.	7 Days.	Average.	4 Days.	7 Days.	4 Days.	7 Days.
		cc.	mgs.	mgs.	mgs.	mgs.	mgs.	mgs.		
1, 2........	Nothing	18.0	3.42 3.25	3.31	3.13 2.97	3.05				
3, 4........	1.227 gms. Con. Tankage......	19.8	83.44 87.83	85.61	94.84 92.34	93.59	82.30	90.54	53.09	58.41
5, 6........	6.220 " Tankage A........	27.3	53.19 55.30	54.22	60.10 61.35	60.72	50.91	57.67	32.84	37.20
7, 8........	1.68 " Blood B...........	20.5	36.60 37.90	37.24	73.71 74.34	74.02	33.93	70.97	21.89	45.78
9, 10........	1.12 " " C..........	19.7	23.26 24.23	23.74	57.12 59.16	58.14	20.43	55.09	13.18	35.54
11, 12........	1.15 " " D..........	19.7	31.24 31.88	31.51	68.70 70.27	69.48	28.20	66.43	18.19	42.85
13, 14........	1.10 " " E..........	19.7	17.16 19.12	18.13	40.06 41.79	40.92	14.82	37.87	9.56	24.43
15, 16........	1.16 " " F..........	19.7	20.43 22.88	21.63	45.39 48.05	46.72	18.32	43.67	11.82	28.17
17, 18........	2.04 " Tankage G........	21.0	59.31 57.68	58.49	73.87 74.34	74.10	55.18	71.05	35.60	45.84
19, 20........	2.31 " " H........	21.5	67.81 66.83	67.32	89.21 86.08	87.64	64.01	84.59	41.29	54.57
21, 22........	2.47 " " I........	21.7	56.70 56.37	56.53	71.36 70.27	70.81	53.22	67.76	34.33	43.71
23, 24........	1.89 " " K........	20.8	65.52 63.89	64.70	81.22 79.82	80.52	61.39	77.47	39.60	49.98
25, 26........	1.91 " " L........	20.9	47.39 49.02	48.20	65.10 69.96	67.53	44.89	64.48	28.96	41.60
27, 28........	2.27 " " M........	21.5	46.03 46.57	46.30	61.82 63.38	62.60	42.99	59.55	27.73	38.42
29, 30........	1.91 " " N........	20.9	55.72 56.70	56.20	75.75 79.03	77.39	55.89	74.34	36.06	47.96
31, 32........	2.32 " " O........	21.5	72.39 69.77	71.07	89.67 89.90	89.83	67.76	86.78	43.71	55.98

AMMONIA PRODUCTION FROM DIFFERENT AMOUNTS OF MATERIAL.

Series B.

For this series varying amounts of organic materials were placed in tumblers containing a soil mixture consisting of 80 grams air dry soil, 20 grams white sand and 0.5 gram ground oyster shells. Water was added as in series A. The following table indicates the arrangement of the series and the yield of ammonia nitrogen at the end of four days:

SOIL PORTION.	Fertilizer or Material Added.	Per cent. N. in Material.	Water Added. cc.	AMMONIA N. RECOVERED.		N. Added. mgs.	Increase over Check. mgs.	Per cent. N. Recovered.
				4 Days. mgs.	Average. mgs.			
1, 2	1 gm. Fert. No. 1 from Jones	1.68	19.5	11.42 12.05	11.73	16.55	8.42	52.62
3, 4	3 " " " " "	1.68	22.5	27.70 28.33	28.01	49.65	24.70	49.74
5, 6	1 " " No. 2 " "	2.43	19.5	7.98 8.29	8.13	24.30	4.82	19.83
7, 8	3 " " " " "	2.43	22.5	25.67 24.88	25.27	72.90	21.96	30.12
9, 10	1 " " No. 3 " "	2.00	19.5	5.16 4.54	4.85	20.00	1.54	7.70
11, 12	3 " " " " "	2.00	22.5	12.36 12.99	12.67	60.00	9.36	15.00
13, 14	1 " Chinese Wood	2.10	19.5	7.36 7.67	7.51	20.96	4.20	20.04
15, 16	3 " " "	2.10	22.5	24.10 22.85	23.47	62.88	20.16	32.06
17, 18	1 " Tankage H	6.72	19.5	33.18 33.80	33.49	65.15	30.18	46.32
19, 20	2 " " "	6.72	21.0	65.42 66.51	65.96	130.30	62.65	48.08
21, 22	1 " " K	8.22	19.5	38.03 37.72	37.87	81.79	34.56	42.25
23, 24	2 " " "	8.22	21.0	79.19 78.72	78.95	163.58	75.64	46.24
25, 26	1 " " M	6.86	19.5	19.41 20.19	19.80	68.60	16.49	24.04
27, 28	2 " " "	6.86	21.0	38.97 40.53	39.75	137.20	36.44	26.56
29, 30	1 " " N	8.13	19.5	31.93 31.14	31.53	81.3	28.22	34.71
31, 32	2 " " "	8.13	21.0	65.26 66.20	65.73	162.6	62.42	38.39
33, 34	1 " " O	6.69	19.5	30.36 31.14	30.75	65.27	27.44	42.04
35, 36	2 " " "	6.69	21.0	64.63 64.95	64.79	130.54	61.48	47.09

With the tankage samples there is quite close agreement between the percentages of nitrogen recovered when different amounts of material were used, and this holds true whether the material was low or high grade. With samples 1, 2 and 3, and the Chinese wood, the agreement is not close. This is probably due to the fact that these materials are very slowly available, and where only one gram was used the amount of ammonia recovered was so little in excess of what was allowed for the blank—3.31 mgs.—as to make the percentage recovery disproportionately low.

There is a rather wide difference in availability between some of the samples that are quite similar in nitrogen content, as, for example, tankages H and M; also fertilizer No. 3 and Chinese wood.

If we compare the average percentage of nitrogen recovered by this method, from the three fertilizer samples—Nos. 1, 2 and 3—with the percentage of available nitrogen as determined by the alkaline permanganate method,[1] we have the following:

	No. 1.	No. 2.	No. 3.
Available N by Ammonification.......	51.18	24.97	11.65
Available N by Alk. perm. Method....	64.00	75.00	44.00

Sample No. 1 was what is known as "Base" goods, made by the "Wet Mix" process. No. 2, nitrogen from dried blood and cottonseed meal (dry mix). No. 3, nitrogen from treated leather, garbage tankage and peat (dry mix). With sample No. 1 the two methods agree fairly well. With No. 2, on the contrary, there is a wide difference. No doubt this difference would have been considerably less had a longer period been allowed for ammonification. It has already been pointed out—series A—that with dried blood the percentage of availability is decidedly higher for seven days than for four days. Attention was also called to the fact that dried blood ammonified more slowly than tankage. These statements will undoubtedly apply, also, to sample No. 3, for the materials used in its preparation were such as are known to ammonify slowly. In comparing the two methods, it may be said of the ammonification method that it shows a wider range of availability, and it may therefore be looked upon as bringing out finer distinctions.

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[1] Determinations made by Charles S. Cathcart.

These results throw further light on the varying rapidity with which different organic materials decay. The close agreement in results as indicated by percentage of nitrogen recovered, when different quantities of material were used, also adds strength to the claim which has been made for this method as a means of determining the availability of nitrogen in organic materials.

THE RELATIVE AVAILABILITY OF BLOOD, TANKAGE, AND FISH, AS INDICATED BY THEIR AMMONIFICATION.

Series C.

Soil samples were prepared as in series A. To these were added amounts of the organic materials equivalent to 155 mgs. of nitrogen. These samples were moistened as indicated in the table and then incubated for periods of four and seven days. At the end of these periods the ammonia was determined in the usual way. The arrangement of the series and the amount of nitrogen recovered are indicated in the following table:

SOIL PORTION NO.	Material Added.	Water Added. cc.	AMMONIA N. RECOVERED. 4 Days. mgs.	Average. mgs.	7 Days. mgs.	Average. mgs.	AVERAGE INCREASE OVER CHECK. 4 Days. mgs.	7 Days. mgs.	AVERAGE PER CENT. NITROGEN RECOVERED. 4 Days.	7 Days.
1, 2........	Nothing	18.00	4.01 3.66	3.84	3.66 3.66	3.66				
3, 4........	1.3217 gms. Blood............	19.98	27.37 27.02	27.19	59.09 61.88	60.48	23.35	56.82	15.06	36.66
5, 6........	1.2270 " Concen. Tankage.	19.80	83.83 83.66	83.75	96.21 91.68	93.94	79.91	90.28	51.55	58.24
7, 8........	1.2233 " Blood No. 1.....	19.85	18.30 19.70	19.00	37.82 37.13	37.47	15.16	33.81	9.78	21.81
9, 10........	1.1932 " " " 6.....	19.80	22.14 22.48	22.31	71.11 68.15	69.63	18.47	65.97	11.91	42.56
11, 12........	1.1968 " " " 10.....	19.80	25.80 26.15	25.97	69.72 71.11	70.42	22.13	66.76	14.28	43.07
13, 14........	2.0367 " " " 23.....	21.00	19.87 19.32	19.59	30.15 29.11	29.63	15.75	25.97	10.16	16.75
15, 16........	1.1381 " " " 51.....	19.70	23.70 24.58	24.14	44.80 46.89	45.84	20.30	42.18	13.00	27.21
17, 18........	1.6939 " " " 66.....	20.55	30.33 31.03	30.68	37.65 37.30	37.47	26.84	33.81	17.31	21.81
19, 20........	1.2223 " " " 78.....	19.85	17.95 18.30	18.13	45.84 45.84	45.84	14.29	42.18	9.22	27.21
21, 22........	1.5316 " " " 162.....	20.30	*73.21 30.33	30.33	57.00 59.09	58.04	26.49	54.33	17.00	35.08
23, 24........	2.2929 " Tankage No. 8..	21.45	58.91 59.26	59.09	66.23 66.76	66.48	55.25	62.82	35.64	40.53
25, 26........	2.1985 " " " 14..	21.30	69.55 70.77	70.16	81.40 81.92	81.66	66.32	78.00	42.79	50.32
27, 28........	3.3842 " " " 16..	23.10	33.81 33.47	33.64	44.62 42.70	43.66	29.80	40.00	19.22	25.81
29, 30........	2.2660 " " " 48..	21.40	73.03 71.99	72.51	77.91 78.44	78.17	68.67	74.51	44.30	48.07
31, 32........	2.6450 " " " 58..	21.95	32.25 33.29	32.77	49.68 50.20	49.94	28.93	46.28	18.66	29.86
33, 34........	3.3264 " " " 50..	23.00	26.15 26.32	26.23	34.51 33.12	33.81	22.39	30.15	14.44	19.45
35, 36........	2.6770 " " " 79..	22.00	35.91 34.69	35.30	54.51 54.68	54.59	31.46	50.93	20.30	32.86
37, 38........	2.6541 " " " 86..	21.95	31.37 31.20	31.28	49.68 48.46	49.07	27.44	45.41	17.70	29.30

* Not included in the average.

SOIL PORTION NO.	Material Added.	Water Added.	AMMONIA N. RECOVERED.				AVERAGE INCREASE OVER CHECK.		AVERAGE PER CENT. NITROGEN RECOVERED.	
		cc.	4 Days. mgs.	Average. mgs.	7 Days. mgs.	Average. mgs.	4 Days. mgs.	7 Days. mgs.	4 Days.	7 Days.
39, 40........	3.2157 gms. Tankage No. 127..	22.80	71.29 72.86	72.07	80.35 82.10	81.22	68.23	77.56	44.02	50.04
41, 42........	2.9026 " " " 128..	22.35	25.80 25.80	25.80	47.06 47.93	52.49	21.96	48.83	14.17	31.50
43, 44........	1.9874 " Fish No. 24....	21.00	63.79 64.49	64.14	80.53 81.92	81.22	60.30	77.56	38.90	50.04
45, 46........	1.9570 " " " 36....	20.90	81.40 86.10	83.75	104.93 104.23	104.58	79.91	100.92	51.55	65.11
47, 48........	2.6006 " " " 37....	21.90	60.83 61.35	61.09	73.55 75.82	74.68	57.25	71.02	36.93	45.82
49, 50........	1.7673 " " " 41....	20.65	81.57 83.66	82.62	101.79 99.70	100.74	78.78	97.08	50.82	62.63
51, 52........	2.5790 " " " 85....	21.85	51.59 51.77	51.68	73.90 74.95	74.42	47.84	70.76	30.86	45.65
53, 54........	1.9254 " " " 111....	20.90	73.73 70.42	72.18	88.02 88.72	88.37	68.34	84.71	44.09	54.65
55, 56........	1.9375 " " " 147....	20.00	70.77 72.16	71.47	88.89 87.50	88.19	67.63	84.53	43.63	54.53
57, 58........	1.9871 " " " 150....	21.00	73.90 75.30	74.60	93.42 95.52	94.47	70.76	90.81	45.65	58.59
59, 60........	2.8336 " " " 152....	22.25	*88.54 107.72	107.72	113.99 115.74	114.86	103.88	111.20	67.02	71.74
61, 62........	1.8810 " " " 161....	20.80	61.35 62.75	62.05	81.05 84.36	82.70	58.21	79.04	37.55	51.00
63, 64........	1.1127 " " " 40....	19.66	70.42 71.64	70.53	82.27 81.92	82.09	66.69	78.43	43.03	50.60
65, 66........	1.5945 " " " 45....	20.40	92.73 89.07	90.90	102.14 100.05	101.09	87.06	97.43	56.17	62.86

* Not included in the average.

As in series A, the tankage shows a higher availability than the blood. It should also be noted that the blood is more uniform in amount of available nitrogen yielded than the tankage, the highest yield for the four-day period being 27.19 mgs., and the lowest being 18.13 mgs. The highest yield from the tankage (concentrated tankage not included) was 72.51 mgs., and the lowest 25.80 mgs. The figures for the fish show even more uniformity and a higher availability than either the blood or tankage. Tabulating the average percentage ammonia nitrogen recovered for the four and seven-day periods, for the three materials, we have the following:

	4 days. Per cent.	7 days. Per cent.
Blood	13.10	30.24
Tankage	27.12	38.35
Fish	45.52	56.10

Here, as in series A, it will be noted that the blood is lower in availability than the tankage, and, also, that it becomes available more slowly than the tankage (this difference also exists between the blood and fish). For example, in blood No. 6 the percentage of nitrogen recovered in four days was 11.91, and in seven days 42.56; and for blood No. 10 it was 14.28 for four days and 43.07 for seven days. No such gains are made from the fourth to the seventh day with tankage or fish.

These results are not altogether in accord with the results secured in the vegetation experiments where the same materials were used. In the vegetation experiments (No. 2) the blood showed a higher availability than the tankage, and quite as high as the fish, the figures being 40.31% nitrogen recovery for the blood, 28.71% for tankage and 40.09% for the fish. This would indicate that in considering the availability of organic materials, due consideration should be given to the time element involved, and it is entirely possible that in using this method as an index of the availability of such materials, it may be found necessary to allow a longer period for ammonification. It is well known that the recovery from such materials is greater with crops having a long growing season.

A comparison of the results secured by this method, and those secured in vegetation tests, shows that it usually indicates those materials that show a low availability in the vegetation tests. The work confirms statements already made to the effect that the method gives fairly concordant results, and that it enables us, to a certain extent, to pick out the materials that have a relatively high or low availability.

Series D.

The general plan of this series is the same as for series C, with the exception that double the amount of organic matter was used. It is intended as a check upon the previous series, and also as a further study of the relative availability of different materials. The quantity and kind of materials used and the results obtained are set forth in the following table:

SOIL PORTION NO.	Material Added.	Water Added.	AMMONIA N. RECOVERED.				INCREASE OVER CHECK.		PER CENT. NITROGEN RECOVERED.	
		cc.	4 Days. mgs.	Average. mgs.	7 Days. mgs.	Average. mgs.	4 Days. mgs.	7 Days. mgs.	4 Days.	7 Days.
1, 2........	Nothing	18.00	4.23 4.23	4.23	3.53 3.71	3.62				
3, 4........	2.6434 gms. Blood............	21.06	67.81 69.93	68.87	122.74 123.97	123.35	64.64	119.73	20.85	38.61
5. 6........	2.4540 " Con. Tankage...	21.60	166.53 189.32	177.92	189.65 193.73	191.69	173.69	188.07	56.03	60.67
7, 8........	2.4466 " Blood No. 1.....	21.70	44.15 45.28	44.72	83.53 85.12	84.32	40.49	80.70	13.06	26.08
9, 10........	2.3864 " " " 6.....	21.60	64.99 67.81	66.40	129.98 133.16	131.57	62.17	127.95	20.05	41.27
11, 12........	2.3936 " " " 10.....	21.60	74.88 84.41	79.34	141.63 141.46	141.54	75.41	137.92	24.32	44.49
13, 14........	4.0734 " " " 23.....	24.00	41.68 42.21	41.94	62.34 60.75	61.54	37.71	57.92	12.16	18.68
15, 16........	2.2762 " " " 51.....	21.40	62.52 62.69	62.61	103.66 107.20	105.43	58.38	101.81	18.83	32.84
17, 18........	3.3878 " " " 66. ...	23.10	62.87 63.58	63.22	77.88 77.70	77.79	58.99	74.17	19.03	23.92
19, 20........	2.4446 " " " 78.....	21.70	43.62 44.86	44.24	90.95 95.01	92.98	40.01	89.36	12.90	28.82
21, 22........	3.0632 " " "162.....	22.00	75.58 75.58	75.58	115.50 114.08	114.79	71.35	111.17	23.01	35.86
23, 24........	4.5858 " Tankage No. 8..	24.90	134.39 131.92	133.15	140.04 141.28	140.66	128.92	137.04	41.59	44.20
25, 26........	4.3970 " " " 14..	24.60	149.05 148.34	148.69	159.65 161.41	160.53	144.46	156.91	46.66	50.61
27, 28........	6.7684 " " " 16..	28.20	74.88 76.64	75.76	94.48 93.77	94.12	71.53	90.50	23.07	29.19
29, 30........	4.5320 " " " 48..	24.80	151.88 154.35	153.11	160.85 162.80	161.82	148.88	157.70	48.02	50.87
31, 32........	5.2900 " " " 58..	25.90	85.30 86.36	85.83	105.25 105.25	105.25	81.60	101.63	26.32	32.78
33, 34........	6.6528 " " " 59..	28.00	63.75 62.34	63.04	77.00 77.35	77.17	58.81	73.55	18.97	23.72
35, 36........	5.3540 " " " 79..	26.00	83.00 84.41	83.70	114.26 112.49	113.37	78.47	109.75	25.31	35.40
37, 38........	5.3082 " " " 86..	25.90	75.58 77.00	76.29	105.78 106.14	105.96	72.06	102.34	23.24	33.01

SOIL PORTION NO.	Material Added.	Water Added. cc.	AMMONIA N. RECOVERED. 4 Days.	AMMONIA N. RECOVERED. Average. mgs.	AMMONIA N. RECOVERED. 7 Days. mgs.	AMMONIA N. RECOVERED. Average. mgs.	INCREASE OVER CHECK. 4 Days. mgs.	INCREASE OVER CHECK. 7 Days. mgs.	PER CENT. NITROGEN RECOVERED. 4 Days.	PER CENT. NITROGEN RECOVERED. 7 Days.
39, 40........	6.4314 gms. Tankage No. 127..	27.00	150.65 159.20	159.47	176.07 171.47	173.77	155.24	170.15	50.08	54.89
41, 42........	5.8062 " " " 128..	26.70	66.93 67.28	67.10	98.90 99.43	98.16	62.87	94.54	20.28	30.49
43, 44........	3.9748 " Fish No. 24.....	24.00	141.64 141.46	141.55	168.30 161.94	165.12	137.32	161.50	44.29	52.09
45, 46........	3.9140 " " " 36.....	23.80	176.78 175.72	176.25	190.37 194.61	192.49	172.02	188.87	55.49	60.92
47, 48........	5.2012 " " " 37.....	25.80	135.10 135.10	135.10	156.47 153.64	155.05	130.87	151.43	42.21	48.85
49, 50........	3.5346 " " " 44.....	23.30	165.83 171.30	168.56	177.31 180.07	181.09	164.33	178.37	53.01	57.54
51, 52........	5.1580 " " " 85.....	25.70	98.90 102.43	100.66	144.64 143.40	144.02	96.43	140.40	31.10	45.29
53, 54........	3.8508 " " " 111.....	23.80	155.05 152.58	153.81	168.48 168.48	168.48	149.58	164.86	48.25	53.18
55, 56........	3.8750 " " " 147.....	23.80	155.76 154.00	154.88	168.83 173.42	171.12	150.65	167.50	48.59	54.03
57, 58........	3.9742 " " " 150.....	24.00	159.82 100.35	160.08	173.77 173.95	173.86	155.85	170.24	50.27	54.91
59, 60........	5.6672 " " " 152.....	26.50	214.22 214.39	214.31	228.52 229.93	229.22	210.08	225.00	67.76	72.77
61, 62........	3.7620 " " " 161.....	23.60	134.57 140.04	137.30	159.12 167.42	163.27	133.07	159.65	42.92	51.50
63, 64........	2.2254 " " " 40.....	21.32	154.70 155.23	154.96	Lost 168.30	168.30	150.73	164.68	48.02	53.12
65, 66........	3.1890 " " " 45.....	22.80	179.00 178.01	178.80	190.90 191.43	191.16	174.57	187.54	56.81	60.49

It will be noted that the amount of ammonia nitrogen recovered in this series during the four day period is, in most cases, somewhat more than double the amount recovered in series C for the same period. For the seven day period the amount recovered from series D is usually about double, or slightly less than double, the amount recovered in series C for the same period.

The average percentage ammonia nitrogen recovered for the 4 and 7 day periods is as follows:

	4 days. Average Per Cent.	7 days. Average Per Cent.
Blood	18.24	32.28
Tankage	32.35	38.52
Fish	49.07	55.39

Comparing these figures with those from the series in which only one-half as much organic material was used, it is seen that the difference is only slight. However, the results for the 7 day period agree more closely than those for the 4 day period. It should be further observed that the blood becomes available more slowly than either of the other materials, thus further confirming the observations made on this point in series A and C.

THE AMMONIFICATION OF ORGANIC MATERIAL IN MIXED FERTILIZERS.

Series E.

Samples of soil were prepared as in series A. Four grams of a mixed fertilizer, containing organic nitrogen, were mixed with the soil, and the mixture placed in the incubator at a temperature of 27°-28° C. for 7 days. At the end of this time the ammonia was distilled off and titrated in the usual manner. The arrangement of the series and the results obtained are given in the table.

SOIL PORTION NO.	Material Added.	Water Added. cc.	AMMONIA N. RECOVERED.		Increase Over Check. mgs.	Organic N. Recovered. %
			7 Days. mgs.	Average. mgs.		
1, 2	Nothing	18.00	1.59 1.76	1.67		
3, 4	1 gm. Stand. Dried Blood	19.50	57.11 50.41	53.76	52.09	44.44
5, 6	4 gms. Fert. No. 10442 (485)	24.00	22.38 22.38	22.38	20.71	25.64
7, 8	" " " 10190 (487)	24.00	24.32 25.38	24.85	23.18	36.07
9, 10	" " " 10359 (496)	24.00	11.99 12.69	12.34	10.67	28.37
11, 12	" " " 10351 (508)	24.00	50.76 52.00	51.38	49.71	57.73
13, 14	" " " 10485 (596)	24.00	32.08 32.43	32.25	30.58	28.81
15, 16	" " " 10456 (463)	24.00	25.91 26.09	26.00	24.33	44.39
17, 18	" " " 10627 (507)	24.00	62.75 62.39	62.57	60.90	33.73
19, 20	" " " 10031 (599)	24.00	71.38 72.44	71.91	70.24	46.75
21, 22	" " " 10336 (656)	24.00	22.03 22.03	22.03	20.36	25.83
23, 24	" " " 10330 (663)	24.00	46.18 45.83	46.00	44.33	37.55
25, 26	" " " 10173 (498)	24.00	81.43 80.37	80.90	79.23	30.59
27, 28	" " " 10149 (502)	24.00	86.36 84.78	85.57	83.90	34.94
29, 30	" " " 10713 (518)	24.00	95.71 96.06	95.88	94.21	51.40
31, 32	" " " 10742 (570)	24.00	74.91 74.91	74.91	73.24	28.29
33, 34	" " " 10717 (581)	24.00	83.72 85.48	84.60	82.93	34.46
35, 36	" " " 10458 (464)	24.00	60.98 61.51	61.24	59.57	67.15
37, 38	" " " 10513 (515)	24.00	49.00 48.47	48.73	47.06	34.57

SOIL PORTION NO.	Material Added.	Water Added. cc.	AMMONIA N. RECOVERED. 7 Days. mgs.	AMMONIA N. RECOVERED. Average. mgs.	Increase Over Check. mgs.	Organic N. Recovered. %
39, 40	4 gms. Fert. No. 10262 (516)........................	24.00	121.97 121.62	121.79	120.12	28.75
41, 42	" " " 10233 (572).......	24.00	125.49 125.67	125.58	123.91	26.84
43, 44	" " " 10250 (574)........................	24.00	144.53 146.64	145.58	143.91	21.00
45, 46	" " " 9100 (790)........................	24.00	87.60 87.05	87.77	86.10	64.73
47, 48	" " " 9557	24.00	50.41 52.52	51.46	49.79	27.75
49, 50	" " " 9506 (705)........................	24.00	105.22 106.63	105.92	104.25	43.00
51, 52	" " " 9662 (821)........................	24.00	108.40 108.40	108.40	106.73	50.27
53, 54	" " " 9881 (683)........................	24.00	30.32 29.08	29.70	28.03	29.72
55, 56	" " " 9834 (830)........................	24.00	23.79 25.03	24.41	22.74	86.91

As in other cases, already pointed out, there is considerable difference in ammonification in the different samples. This is well illustrated in the samples used with soil portions 43-44 and 45-46. With the former only 21.00% of the organic nitrogen of the fertilizer was recovered, while with the latter 64.73% was recovered. Since certain of these samples were used in both the ammonification and vegetation tests in 1910, the following comparison of percentage nitrogen recovered will be of interest:

Mixed fert. No.	Ammonification test, 1910.	Ammonification test, 1911.	Vegetation test, 1910.
9557	27.20	27.75	10.13
9506	63.40	43.00	12.92
9662	36.50	50.27	57.40
9881	24.80	29.72	75.98
9834	24.40	36.91	15.79

Here we find a wide range of availability for the different materials. The availability by the ammonification method for the two years is in fair agreement, the greatest difference being 20.4 in No. 9,506. When we come to the vegetation tests for 1910 we find quite a wide variation. Samples 9,662 and 9,881 show a high availability by this method, and this was to have been expected since the time factor enters to give it an advantage over the other method. It is of interest to note that No. 9,662 shows a high availability by the ammonification method also, for both years. The same can hardly be said of No. 9,881, however. It is not quite clear why the other three should have shown such a low availability by the vegetation method. With the standard dried blood there was recovered, by the ammonification method, in 1910 and 1911, 55.3% and 44.44%, respectively, and by the vegetation test in 1910, 31.49%. The average percentage recovered for all the mixed samples by the ammonification method for 1911 was 37.46%, which is only a little less than was recovered from the standard dried blood for that year.

AVAILABILITY OF NITROGEN IN MIXED FERTILIZERS, WHEN DIFFERENT AMOUNTS OF MATERIAL WERE USED.

Series F.

Samples for this series were prepared as for the preceding series—series E. In this case, however, 2, 4 and 8 grams of the fertilizer were used. The results obtained at the end of 7 days are reported in the following table:

SOIL PORTION NO.	Material Added.	Water Added. cc.	AMMONIA N. RECOVERED. 7 Days. mgs.	AMMONIA N. RECOVERED. Average. mgs.	Increase Over Check. mgs.	Organic N. Recovered. %
1, 2	Nothing	18.00	1.94 1.59	1.76		
3, 4	1.3234 gms. Stan. Dried Blood	20.00	60.81 69.44	65.12	63.36	40.87
5, 6	2.000 " Fert. No. 10456	21.00	14.81 15.51	15.16	13.40	48.90
7, 8	4.000 " " " "	24.00	25.91 26.09	26.00	24.24	44.23
9, 10	8.000 " " " "	30.00	46.53 47.59	47.06	45.30	41.33
11, 12	2.000 " " " 10627	21.00	31.02 32.25	31.63	29.87	31.71
13, 14	4.000 " " " "	24.00	62.92 63.45	63.18	61.42	34.02
15, 16	8.000 " " " "	30.00	Lost 119.15	119.15	117.39	29.95
17, 18	2.000 " " " 10931	21.00	36.31 38.07	37.19	35.43	47.78
19, 20	4.000 " " " "	24.00	71.21 72.09	71.65	69.89	46.17
21, 22	8.000 " " " "	30.00	132.90 133.43	133.16	131.40	39.23
23, 24	2.000 " " " 10149	21.00	45.47 46.53	46.00	44.24	41.03
25, 26	4.000 " " " "	24.00	84.78 85.66	85.22	83.46	34.20
27, 28	8.000 " " " "	30.00	152.28 161.80	157.04	155.28	25.79
29, 30	2.000 " " " 10713	21.00	48.12 47.94	48.03	46.27	49.08
31, 32	4.000 " " " "	24.00	95.00 94.12	94.56	92.80	49.44
33, 34	8.000 " " " "	30.00	174.67 185.07	179.87	178.11	44.24
35, 36	2.000 " " " 10742	21.00	40.71 39.30	40.00	38.24	83.00
37, 38	4.000 " " " "	24.00	78.44 77.56	78.00	76.24	32.70

SOIL PORTION NO.	Material Added.	Water Added. cc.	AMMONIA N. RECOVERED.		Increase Over Check. mgs.	Organic N. Recovered. %
			7 Days. mgs.	Average. mgs.		
39, 40	8.000 gms. Fert. No. 10742	30.00	141.86 142.90	142.38	140.62	23.98
41, 42	2.000 " " " 10458	21.00	31.80 31.62	31.71	20.95	67.59
43, 44	4.000 " " " "	24.00	60.23 61.91	61.07	59.31	66.81
45, 46	8.000 " " " "	30.00	110.93 111.46	111.19	109.43	60.73
47, 48	2.000 " " " 10513	21.00	26.03 25.16	25.59	23.83	35.13
49, 50	4.000 " " " "	24.00	47.68 49.44	48.56	46.80	34.32
51, 52	8.000 " " " "	30.00	82.46 88.75	85.60	83.84	29.77
53, 54	2.000 " " " 10262	21.00	62.19 62.02	62.10	60.34	29.58
55, 56	4.000 " " " "	24.00	121.42 122.62	122.02	120.26	28.95
57, 58	8.000 " " " "	30.00	238.47 239.33	238.90	237.14	26.44
59, 60	2.000 " " No. 1 from C. H. Jones	21.00	16.95 16.77	16.86	15.10	33.06
61, 62	4.000 " " " " " "	24.00	34.68 34.68	34.68	32.92	38.20
63, 64	8.000 " " " " " "	30.00	67.78 67.43	67.60	65.84	38.20
65, 66	2.000 " " " 2 " "	21.00	19.86 19.86	19.86	18.10	35.42
67, 68	4.000 " " " " " "	24.00	39.55 34.68	37.11	35.35	34.56
69, 70	8.000 " " " " " "	30.00	58.03 60.29	59.16	57.40	27.83
71, 72	2.000 " " " 3 " "	21.00	5.58 5.40	5.49	3.73	5.29
73, 74	4.000 " " " " " "	24.00	9.76 9.93	9.83	8.08	6.06
75, 76	8.000 " " " " " "	30.00	17.95 18.31	18.13	16.37	6.20

From these results it is found that in most cases the percentage of organic nitrogen recovered where 4 grams were used is quite close to the amount recovered from 2 grams. With two exceptions, viz., portions 63 and 64, and 75 and 76 the percentage recovered from the 8 gram portions is always less than that from either the 2 or 4 gram portion. This is probably due to a more thorough utilization of the smaller amounts. With the smaller amounts a more even distribution would probably be secured and there would be more soil and consequently more bacteria for a given amount of material. Excluding fertilizer sample No. 3 (portions 71-76) it is found that the lowest percentage recovered was 23.98 and the highest 67.59. Three of the samples only showed a percentage recovery above 50, while the average for all the mixed samples (excluding No. 3) was 39.05. The average for all the mixed samples in series E was 37.46%. The percentage recovered from the standard dried blood was 40.87, this being slightly more than the average for all, and quite close to the percentage recovery for this material in series D and E.

It should here be explained that sample No. 3 was made from treated leather, garbage tankage and peat, and this no doubt accounts for the low availability shown. With only a few exceptions, concordant results were obtained on duplicate determinations throughout this series.

THE INFLUENCE OF NITRATE OF SODA ON THE AVAILABILITY OF NITROGEN IN PEAT AND DRIED BLOOD.

Series G.

In a previous communication[1] it was pointed out that nitrate of soda apparently favors the accumulation of larger amounts of ammonia when used in connection with an inert substance like peat. This experiment was planned as a check upon the earlier work.

The soil samples were prepared as in series A. The organic and inorganic materials to the extent of 155 mgs. of nitrogen, were added, together with the proper amount of moisture, and the whole incubated for a period of seven days in the usual manner. At the end of this period the ammonia was determined. The arrangement of the series and the amounts of ammonia nitrogen recovered are indicated in the following table:

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[1] Report of Soil Chemist and Bacteriologist, 1910.

SOIL PORTION NO.	Material Added.	Water Added. cc.	AMMONIA N. RECOVERED.		Increase Over Check. mgs.	Per Cent. N. Recovered.
			7 Days. mgs.	Average. mgs.		
1, 2	Nothing	18.00	3.00 3.35	3.17		
3, 4	1.3234 gms. Stand. Dried Blood	20.00	71.56 79.31	75.43	72.26	46.61
5, 6	6.1507 " Peat	27.00	4.76 4.76	4.76	1.50	1.25
7, 8	5.5555 " " + .1 gm. $NaNO_3$	27.00	10.22 9.69	9.95	6.78	4.37
9, 10	5.5555 " " + .0782 gm. $(NH_4)_2SO_4$	27.00	14.07 12.34	13.21	10.04	6.47
11, 12	5.5555 " " + .1323 gm. Stand. Blood	27.00	74.91 71.38	73.14	69.97	45.14

From an examination of the table it will be observed that the standard dried blood yielded on an average 75.43 mgs. of ammonia nitrogen, while the peat alone yielded only 4.76 mgs. A quantity of the peat (5.555 gms.) which, with 0.1 gram nitrate of soda would make up the 155 mgs. of nitrogen, yielded 9.95 mgs. of ammonia nitrogen which is an increase of 5.19 mgs. over the peat alone. This corroborates the earlier work and indicates that in the presence of nitrate nitrogen the ammonification of inert materials is stimulated.

Comparing soil portions 9 and 10, in which 78.2 mgs. of sulphate of ammonia were used, with 5 and 6 in which peat alone was used, it would appear that the sulphate of ammonia had a depressing effect upon the ammonification of the peat, since the amount of ammonia recovered is less than the amount in the sulphate of ammonia used. This is substantially in agreement with the earlier work referred to above, where it was found that the ammonium sulphate did not aid in the ammonification of the peat. With portions 11 and 12 there appears to be an error in the amount of standard blood taken, for, when we compare the amount of ammonia nitrogen recovered in this case with the amount recovered from the standard blood alone, and the peat alone, portions 3 and 4, and 5 and 6, we see at once that it is more than could be obtained (under these conditions) from the peat and .1323 grams of the blood. It would, therefore, seem that 1.3234 grams blood were weighed out instead of .1323 gram as reported in the table. If this assumption is correct, and there seems good reason to believe that it is, then the peat must have had a depressing effect upon the yield of ammonia from the blood, since the amount here recovered is less by 2.29 mgs. than the amount recovered from the standard dried blood alone in portions 3 and 4. The blood is not only inefficient in promoting ammonification in the peat, but seems to lose some of its own efficiency. This is made clear in the table under column headed "percentage of nitrogen recovered." This also is in agreement with the work reported in 1910, reference to which has already been made.

THE INFLUENCE OF INCREASING AMOUNTS OF SODIUM NITRATE ON THE AMMONIFICATION OF DRIED BLOOD, COTTONSEED MEAL AND PEAT.

Series H.

The soil samples were prepared as in series A, except that 75% of water was added for the organic matter. Quantities of dried blood, cottonseed meal, and peat equivalent to 155 mgs. nitrogen were used. The samples were incubated for seven days in the usual way, and the nitrogen determined. The quantities of nitrate of soda used and the ammonia nitrogen recovered in each case are reported in the following table:

Soil Portion No.	Materials Added.	Water Added.	AMMONIA N. RECOVERED.	
		cc.	7 days. mgs.	Average. mgs.
1, 2	1.3217 gms. Dried Blood	22.00	85.73 83.61	84.67
3, 4	" " " " + 1 mg. NaNo$_3$	"	81.83 89.43	85.64
5, 6	" " " " + 3 " "	"	84.67 99.49	92.08
7, 8	" " " " + 5 " "	"	88.55 103.87	95.96
9, 10	" " " " + 10 " "	"	73.03 82.20	77.61
11, 12	2.4218 " Cottonseed Meal	25.00	76.56 77.97	77.26
13, 14	" " " " + 1 mg. NaNo$_3$	"	77.09 75.85	76.47
15, 16	" " " " + 3 " "	"	77.09 79.03	78.06
17, 18	" " " " + 5 " "	"	72.68 76.03	74.35
19, 20	" " " " + 10 " "	"	76.20 78.32	77.26
21, 22	6.1547 " Peat	36.00	5.64 5.29	5.46
23, 24	" " " + 1 mg. NaNo$_3$	"	5.47 5.64	5.55
25, 26	" " " + 3 " "	"	4.59 4.59	4.59
27, 28	" " " + 5 " "	"	4.41 4.41	4.41
29, 30	" " " + 10 " "	"	4.41 4.41	4.41

With the dried blood alone the yield of ammonia was 84.67 mgs.; with the addition of 1, 3 and 5 mgs. nitrate of soda there was a gradual increase to 95.96 mgs. ammonia nitrogen; with the addition of 10 mgs. nitrate of soda the amount dropped to 77.61 mgs. With cottonseed meal the amount of ammonia nitrogen recovered was slightly less than with the blood, but the varying quantities of nitrate of soda appear to have had no influence one way or the other. The peat alone yielded 5.46 mgs. of ammonia, and practically the same result was obtained when 1 mg. nitrate of soda was added. With the addition of 3, 5 and 10 mgs. of nitrate of soda there was a slight decrease in the amount of ammonia recovered.

In this experiment the nitrate of soda appears to have had but little influence on the ammonification of the organic materials. This may possibly be attributed to the fact that the amounts of nitrate added were too small to make any difference.

THE INFLUENCE OF FINENESS OF DIVISION ON THE AVAILABILITY OF NITROGEN IN DRIED BLOOD.

Series I.

Soil samples were prepared as in series A. To these was added an amount of dried blood, in varying degrees of fineness, equivalent to 155 mgs. of nitrogen. These samples were incubated for 7 days, and at the end of this period the nitrogen determined in the usual manner.

The arrangement of the series and the ammonia nitrogen recovered are reported in the following table:

SOIL PORTION NO.	Material Added.	Water Added. cc.	AMMONIA N. RECOVERED.		Increase Over Check mgs.	Per Cent. N. Recovered.
			7 Days. mgs.	Average. mgs.		
1, 2	Nothing	18.00	3.35 3.17	3.26		
3, 4	1.5930 gms. Original Sample of Blood	20.40	53.05 66.80	59.92	56.66	36.55
5, 6	1.5515 " passed through a 1-mm. sieve	20.30	63.98 66.10	65.04	61.78	39.85
7, 8	1.5048 " through ½-mm. sieve	20.25	65.92 67.68	66.80	63.50	40.90
9, 10	1.4818 " " ¼-mm. "	20.20	64.86 64.86	64.86	61.60	39.73
11, 12	1.4932 " " 100-mesh "	20.20	66.27 66.80	66.53	63.27	40.81
13, 14	1.1577 " Blood Flour, Swift's Soluble	19.70	74.03 73.67	73.85	70.59	45.54
15, 16	1.3500 " Concen. Tankage, Swift's	20.00	96.06 97.29	96.67	93.41	60.26

The average yield of ammonia from the original sample of dried blood was 59.92 mgs.; however, the two determinations do not agree closely. The yield from the samples of varying degrees of fineness is quite uniform, and none of the averages is higher than the highest result on the original dried blood. From this it would appear that the finer grades were not more readily ammonified than the original sample.

This is not in accord with the vegetation tests (Exp't No. 3) where it was found that the finer grades, that is, those passing the finer sieves, showed a higher percentage of recovery. Other experiments are now in progress, and it is hoped that these will throw further light on this question.

The soluble blood flour and the concentrated tankage, on account of their more ready solubility, yielded a higher percentage of nitrogen than the other materials. These also gave a high percentage nitrogen recovery, and were high in dry matter in the vegetation experiments.

THE INFLUENCE OF STIMULANTS ON AMMONIFICATION.

Series J.

The soil portions were made up as in series A. Dried blood equivalent to 155 mgs. of nitrogen, 6 cc. of soil infusion and 15 cc. of water were added. The samples were then incubated in the usual way for seven days, and the ammonia determined. The following table indicates the kind and amount of stimulant used and the ammonia nitrogen recovered:

Soil Portion No.	Materials Added.	AMMONIA N. RECOVERED. 7 days. mgs.	AMMONIA N. RECOVERED. Average. mgs.
1, 2	Nothing	76.03 88.55	82.28
3, 4	0.01 mg. Potassium Iodide	80.43 91.20	85.81
5, 6	0.05 " " "	89.43 81.32	85.37
7, 8	0.10 " " "	Lost. 84.32	84.32
9, 10	1.00 " " "	98.43 73.03	85.73
11, 12	0.01 " Copper Sulphate	84.67 78.85	81.75
13, 14	0.05 " " "	74.79 75.50	75.14
15, 16	0.10 " " "	89.08 91.73	90.40
17, 18	1.00 " " "	67.38 74.44	70.91
19, 20	0.01 " Zinc Sulphate	69.32 82.20	75.76
21, 22	0.05 " " "	77.97 75.32	76.64
23, 24	0.10 " " "	75.15 77.44	76.30
25, 26	1.00 " " "	83.26 73.03	78.14
27, 28	0.01 " Manganese Sulphate	68.09 75.32	71.70
29, 30	0.05 " " "	67.91 89.96	78.93
31, 32	0.10 " " "	78.67 74.44	76.55
33, 34	1.00 " " "	66.50 68.62	67.56

With no stimulant 82.28 mgs. (average) of ammonia nitrogen were recovered; however, the duplicates do not agree as closely as they should. Comparing these figures with those obtained where the various stimulants were used, it will be seen that the difference is not great. With 0.1 gram of copper sulphate there is, apparently, a slight stimulating effect. The decrease in the yield where 1.0 gram of this material was used indicates a depressing effect. The yields with zinc sulphate and manganese sulphate are slightly below the yields with potassium iodide and copper sulphate. With 1.0 gram of manganese sulphate there is a distinct depressing effect. While the results indicate a slight depressing effect with some of the stimulants used, and a stimulating effect in one instance, there is not sufficient evidence upon which to base conclusions. Further work along this line will be undertaken.

INFLUENCE OF FERROUS SULPHATE AND CALCIUM SULPHATE ON AMMONIFICATION.

Series K.

The soil samples were prepared as in series A. Two grams of the organic nitrogenous material, and one and two mg. portions of the sulphates were used. The samples were incubated for seven days in the usual manner, and the nitrogen determined. The arrangement of the series and the nitrogen recovered are shown in the following table:

Soil Portion No.	Materials Added.	Nitrogen in Material Added. mgs.	AMMONIA N. RECOVERED.	
			7 days. mgs.	Average. mgs.
1, 2	2.0 gm. Dried Blood....................	234.54	71.27 100.20	85.73
3, 4	" " " " + 1 mg. $FeSO_4$.....	"	104.43 89.96	97.19
5, 6	" " " " + 2 " "	"	94.73 100.90	97.81
7, 8	" " Cottonseed Meal................	123.06	58.56 58.92	58.74
9, 10	" " " " + 1 mg. $FeSO_4$.	"	58.21 50.45	54.33
11, 12	" " " " + 2 " " .	"	58.92 58.04	58.48
13, 14	" " Dried Blood + 1 mg. $CaSO_4$.....	234.54	100.90 99.49	100.19
15, 16	" " " " + 2 " "	"	103.72 99.14	101.43
17, 18	" " Cottonseed Meal + 1 mg. $CaSO_4$.	123.06	58.56 58.39	58.47
19, 20	" " " " + 2 " " .	"	60.33 59.98	60.15

With two grams of dried blood alone 85.73 mgs. (average) of nitrogen were recovered. With one and two mgs. of ferrous sulphate 97.19 and 97.81 mgs. of nitrogen, respectively, were recovered. With the cottonseed meal the results were practically the same with and without the ferrous sulphate. The nitrogen recovered from dried blood with calcium sulphate was a little more than 100 mgs. as against 85.73 mgs. with the blood alone. The amounts recovered from cottonseed meal with calcium sulphate correspond very closely to the amounts recovered with cottonseed meal and ferrous sulphate. In view of the fact that the duplicates on the two gram sample of dried blood do not agree closely, the evidence does not seem sufficient to warrant us in saying that either of these sulphates favors ammonification.

THE INFLUENCE OF AVAILABLE PHOSPHATES ON AMMONIFICATION.

Series L.

Soil samples were prepared as in series A. Two grams of dried blood and 100 mgs. of calcium sulphate were added in each case. The samples were incubated for seven days in the usual way and the ammonia determined at the end of this period. The following table shows the kind and amount of phosphate used and the ammonia nitrogen recovered:

Soil Portion No.	Phosphates Added.	Nitrogen in Dried Blood Added.* mgs.	Ammonia N. Recovered.	
			7 days. mgs.	Average. mgs.
1, 2	Nothing	234.54	97.90 99.14	98.52
3, 4	100 mgs. Ground Phosphate Rock (Germofert),	"	101.61 105.49	103.55
5, 6	100 " Acid Phosphate	"	114.31 114.84	114.57
7, 8	100 " Basic Slag	"	103.02 113.95	108.48
9, 10	100 " Ground Phosphate Rock (Lincoln)	"	96.49 102.84	99.66
11, 12	100 " Fused Phosphate Rock (Newberry)	"	136.89 121.36	129.12

With no phosphate the yield of ammonia was 98.52 mgs.; with the various forms of phosphate the yield was increased slightly, the largest yield being 129.12 mgs. with fused phosphate rock.

These results seem to justify the conclusion that the phosphates, both acid and alkaline, are slightly favorable to ammonification processes.

THE INFLUENCE OF HORSE AND COW MANURE ON THE AMMONIFICATION OF DRIED BLOOD.

Series M.

This experiment was planned with the idea of determining whether or not a very heavy bacterial infection will increase ammonification. It was shown, for example, in an earlier paper,[1] that with 50 gram portions of soil a given amount of dried blood yielded 126.4 mgs. of ammonia nitrogen; with 100 gram portions of soil the blood yielded 273.44 mgs. of ammonia nitrogen, and with 200 gram portions of soil it yielded 449.09 mgs. of ammonia nitrogen. It was there pointed out that the larger yields of ammonia from the larger quantities of soil were influenced both by the numbers of bacteria supplied, and the chemical and physical conditions created by the soil itself. In view of the large numbers of bacteria usually found in manure—1 gram of manure may contain as high as 100 millions of bacteria—this seemed a suitable material for use in this experiment.

The amount of soil and sand used were the same as in series A. The infusion was made with one part manure and two parts water. The samples were placed in the incubator at 27°-28° C. for 7 days, and the ammonia nitrogen determined at the end of this period. The following table shows the arrangement of the series and the amount of manure infusion added.

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[1] Report Soil Chemist and Becteriologist, N. J. Sta.. 1909, p. 138.

Soil Portion No.	Infusion Added.	Amount of N. in Dried Blood. mgs.	Water Added. cc.	AMMONIA N. FOUND.	
				7 days. mgs.	Average. mgs.
1, 2	1 cc. cow manure infusion...	Nothing.	17.00	3.49 3.49	3.49
3, 4	No. infusion	155	20.00	91.13 78.06	84.59
5, 6	1 cc. cow manure infusion...	155	19.00	71.44 82.07	76.75
7, 8	1 " horse " " ...	Nothing.	17.00	4.01 4.01	4.01
9, 10	1 " " " " ...	155	19.00	74.75 74.93	74.84
11, 12	3 " cow " " ...	Nothing.	15.00	4.36 4.70	4.53
13, 14	3 " " " " ...	155	17.00	76.32 72.84	74.58
15, 16	3 " horse " " ...	Nothing.	15.00	4.53 4.18	4.35
17, 18	3 " " " " ...	155	17.00	86.43 75.10	80.76
19, 20	5 " cow " " ...	Nothing.	13.00	4.53 4.36	4.44
21, 22	5 " " " " ...	155	15.00	78.41 60.98	69.69
23, 24	5 " horse " " ...	Nothing.	13.00	3.83 3.83	3.83
25, 26	5 " " " " ...	155	15.00	82.42 85.38	83.90

While the differences are not pronounced, it is to be observed, in each case, that slightly less ammonia was recovered where manure infusions were used than where the blood alone was used. The lowest amount of ammonia obtained from dried blood was 74.58 mgs. where 3 cc. of cow manure infusion were used. If we deduct from this the 4.53 mgs. furnished by the 3 cc. of infusion, we have left 70.05 mgs. which may be attributed to the ammonification of the dried blood in the presence of the infusion. This is 14.54 mgs. less than the amount furnished by dried blood with no infusion. Where the infusion of cow manure was increased to 5 cc. the amount of ammonia recovered was slightly less than where 3 cc. were used. With the increase in horse manure infusion the opposite was true. From the results we would seem justified in concluding that an unusually heavy infection does not materially affect ammonification; on the other hand, it is possible that the number of bacteria in the air dry soil used was so great as to nullify the influence of the bacteria in the manure.

EXPERIMENTS ON AMMONIA FORMATION IN THE PRESENCE OF CARBOHYDRATES AND OF OTHER NON-NITROGENOUS ORGANIC MATTER.

RETARDING EFFECT OF DIFFERENT SUGARS ON THE AMMONIFICATION OF DRIED BLOOD.

Series N.

Samples of soil containing dried blood equivalent to 155 mgs. of nitrogen were prepared in the usual way. These were placed in the incubator and kept at 27°-28° C. for 7 days. At the end of this period the ammonia was determined as usual. The following table shows the amount and kind of sugar used and the ammonia nitrogen recovered:

Soil Portion No.	Additions.	Water added. cc.	AMMONIA N. RECOVERED. 7 days. mgs.	AMMONIA N. RECOVERED. Average. mgs.
1, 2	Nothing	20.00	74.93 77.02	75.97
3, 4	2 gms. Dextrose	23.00	67.61 58.20	62.90
5, 6	2 " Saccharose	23.00	54.02 56.28	55.15
7, 8	2 " Lactose	23.00	36.94 35.02	35.98
9, 10	2 " Maltose	23.00	43.39 43.74	43.56
11, 12	2 " Mannite	23.00	37.46 38.34	37.90

From this table it will be noted that in each case where a sugar was used, less ammonia was recoverd than where blood alone was used. With lactose the amount was 40 mgs. less than the amount recovered from the dried blood.

The least depression occurs with dextrose. These results are in accord with results reported in series V and also with work reported in an earlier paper.[1] Either ammonification is in some way retarded, or through some agency the ammonia after being formed is changed into insoluble forms so that it is not recovered in the distillate. The question may here be raised as to why these sugars act in this way; and why lactose, for example, has a greater depressing effect than dextrose. Is it because more acid is formed with lactose, and thereby is set up a condition more unfavorable to bacterial development? Or is it due to the chemical structure of the molecule? The answer to these questions will have to be left for further study.

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[1] Report of Soil Chemist and Bacteriologist, N. J. Sta., 1909. Series P.

THE DAILY PRODUCTION OF AMMONIA NITROGEN WHEN VARYING AMOUNTS OF DRIED BLOOD ARE USED, CARBOHYDRATES BEING ABSENT.

Series O.

In this experiment, 80 grams soil, 20 grams sand, 0.5 gram calcium carbonate and dried blood equivalent to 155, 310 and 465 mgs. of nitrogen were used. Six cc. soil infusion, 12 cc. water and 60% of moisture for organic matter were added. The mixture was kept in tumblers at room temperature. The arrangement of the series and the amount of ammonia nitrogen recovered are indicated in the following table and the accompanying diagram of curves:

Soil Portion No.	Nitrogen in Dried Blood Added. mgs.	Ammonia N. Recovered. mgs.	Average. mgs.	At End of
1, 2	155	3.00 3.70	3.34	1 day.
3, 4	310.	3.90 4.59	4.24	"
5, 6	465	5.64 5.47	5.55	"
7, 8	155	4.59 4.23	4.41	2 days.
9, 10	310	6.00 6.17	6.08	"
11, 12	465	7.76 8.47	8.11	"
13, 14	155	8.27 8.10	8.18	3 days.
15, 16	310	14.96 15.32	15.14	"
17, 18	465	19.72 19.89	19.80	"
19, 20	155	14.08 15.32	14.70	4 days.
21, 22	310	27.46 34.68	31.07	"
23, 24	465	43.48 48.59	46.03	"
25, 26	155	25.00 26.05	25.52	5 days.
27, 28	310	50.00 52.28	51.14	"
29, 30	465	68.31 69.01	68.66	"
31, 32	155	52.11 55.48	54.04	6 days.
33, 34	310	78.69 83.45	81.07	"
35, 36	465	122.18 124.29	123.23	"
37, 38	155	66.19 61.27	63.73	7 days.
39, 40	310	97.00 99.64	98.32	"
41, 42	465	145.24 143.30	144.27	"
43, 44	155	72.18 73.94	73.06	8 days.
45, 46	310	109.15 107.39	108.27	"
47, 48	465	165.31 164.43	164.87	"
49, 50	155	56.69 53.52	55.10	9 days.
51, 52	310	120.77 117.95	119.36	"
53, 54	465	171.82 173.58	172.70	"
55, 56	155	59.50 63.55	61.53	10 days.
57, 58	310	128.34 128.69	128.51	"
59, 60	465	185.20 186.61	185.91	"

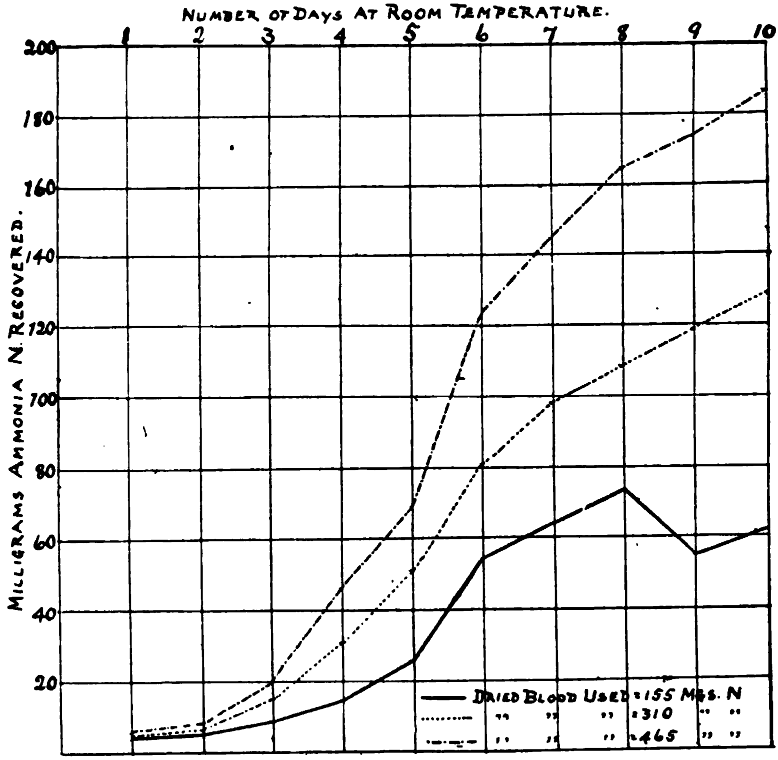

Fig. 1.
The ammonification of Dried Blood.

From the diagram it will at once be observed that the difference in the amount of ammonia nitrogen recovered from the different amounts of blood, up to the end of the second day, is not great; beginning with the third day the difference is fairly proportional to the amount of blood used, with a gradual and sometimes rather rapid increase from day to day, with one exception only; on the ninth day the yield from the 155 mg. portion is slightly decreased, then slightly increased on the following day. Such slight variations are easily explained since it was not possible to keep the room at the same temperature from day to day. It is also to be noted that the lines are almost horizontal to the end of the second day, indicating but little increase in ammonification during this time. Beginning with the third day the increase in production is greater, and appears to have become the most intense from the fifth to the sixth day.

From the diagram of curves it is readily seen that with a given organic material uninfluenced by other materials, the rate of ammonification is fairly proportional to the time elapsing up to the tenth day, and that it is also fairly proportional to the amount of material used. As shown in the diagram for series P, this does not hold true when a carbohydrate (like dextrose) is used with the organic matter.

DAILY PRODUCTION OF AMMONIA AS AFFECTED BY THE PRESENCE OF DEXTROSE.

Series P.

In this experiment 80 grams of soil, 20 grams of sand and 0.5 gram of calcium carbonate were placed in tumblers and kept at room temperature. Three such portions, containing an amount of dried blood equivalent to 155 mgs. nitrogen, 310 mgs. and 465 mgs., respectively, were prepared for each day up to nine days. To the 310 mg. portion and the 465 mg. portion were added 0.5 gram and 3.0 grams, respectively, of dextrose. The arrangement of the series and the amount of ammonia nitrogen recovered from the three portions at the end of each day are indicated in the following table:

Soil Portion No.	Nitrogen in Dried Blood Added.	Ammonia N. Recovered. mgs.	Average. mgs.	At End of
1, 2	155 mgs.	3.70 3.88	3.79	1 day.
3, 4	310 " + .5 gm. Dextrose...	1.06 1.76	1.41	"
5, 6	465 " + 3.0 " " ...	1.58 1.41	1.49	"
7, 8	155 "	5.81 5.81	5.81	2 days.
9, 10	310 " + .5 gm. Dextrose...	1.76 2.11	1.93	"
11, 12	465 " + 3.0 " " ...	1.06 1.06	1.06	"
13, 14	155 "	8.10 8.80	8.45	3 days.
15, 16	310 " + .5 gm. Dextrose...	4.93 5.81	5.37	"
17, 18	465 " + 3.0 " " ...	1.41 1.76	1.58	"
19, 20	155 "	11.09 10.03	10.56	4 days.
21, 22	310 " + .5 gm. Dextrose...	8.10 9.50	8.80	"
23, 24	465 " + 3.0 " " ...	1.41 1.58	1.49	"
25, 26	155 "	16.90 17.45	17.17	5 days.
27, 28	310 " + .5 gm. Dextrose...	15.63 14.90	15.26	"
29, 30	465 " + 3.0 " " ...	1.45 1.09	1.27	"
31, 32	155 "	32.35 32.71	32.53	6 days.
33, 34	310 " + .5 gm. Dextrose...	29.26 30.90	30.08	"
35, 36	465 " + 3.0 " " ...	1.45 1.81	1.63	"
37, 38	155 "	48.89 39.26	44.07	7 days.
39, 40	310 " + .5 gm. Dextrose...	35.98 38.53	37.25	"
41, 42	465 " + 3.0 " " ...	3.27 2.36	2.81	"
43, 44	155 "	44.16 47.89	46.02	8 days.
45, 46	310 " + .5 gm. Dextrose...	45.62 49.44	47.53	"
47, 48	465 " + 3.0 " " ...	4.91 4.73	4.82	"
49, 50	155 "	40.35 44.53	42.44	9 days.
51, 52	310 " + .5 gm. Dextrose...	48.62 50.16	46.89	"
53, 54	465 " + 3.0 " " ...	7.27 6.91	7.09	"

Throughout the series, with one exception, the portion containing the largest amount of blood and the 3 grams of dextrose, yielded much less ammonia nitrogen than either of the other portions. For the first three days the portion receiving the 0.5 gram dextrose also yielded distinctly less nitrogen than the portion receiving only half as much blood and no dextrose. For the fourth, fifth, sixth and seventh days the yield from the double portion of blood and .5 gram dextrose was slightly less than from the smallest portion of blood, without dextrose. During the eighth and ninth days the yield from the double portion of blood and .5 gram dextrose was slightly greater than from the smallest portion of blood and no dextrose. From this work it is quite clear that the amount of ammonia nitrogen recovered when 3 grams of dextrose are used, is very much less than when no dextrose is used, even though three times as much blood be used as was used where no dextrose was employed. With .5 gram dextrose and the double portion of blood, the amount of ammonia nitrogen is still less than where no dextrose was used, up to the eighth day. For the eighth and ninth days the amount recovered was practically the same with the single portion of dried blood, and with the double portion and .5 gram dextrose.

These facts are well illustrated in the curves shown in the accompanying diagram, and if these curves be compared with those in the diagram accompanying series O, we at once note the very pronounced effect of the dextrose on ammonia production. Due allowance should be made for slight irregularities due to a little variation in the daily temperature.

Here, as in series Q, the dextrose either has a depressing effect upon the yield of ammonia nitrogen, or its presence favors the development of those organisms which use ammonia; the latter view is more probable. It may also be pointed out that, while dextrose and other carbohydrates do seem to have a depressing effect on ammonification, still a point is finally reached beyond which depression is not great; that is, with relatively large amounts of dried blood the depression is comparatively small. This is illustrated by the line indicating 310 grams of blood with .5 gram dextrose.

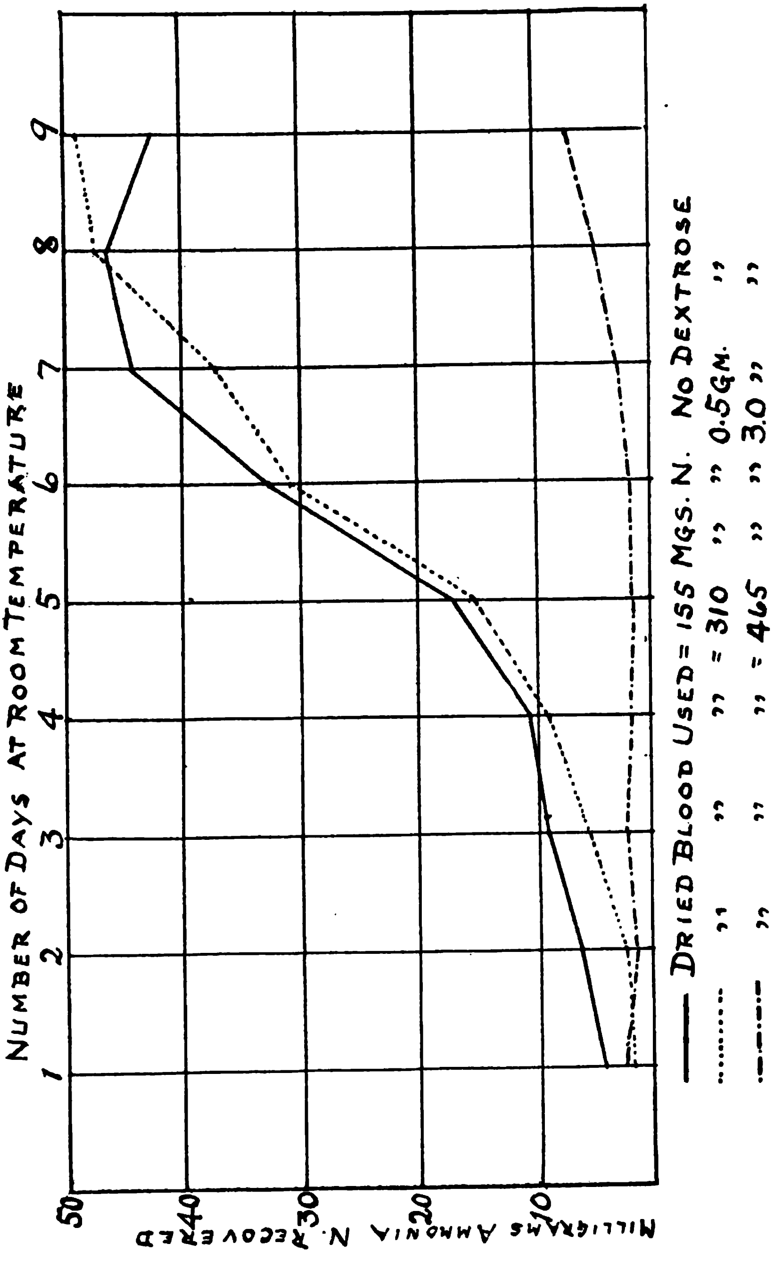

Fig. 2.

The Influence of Dextrose on the Ammonification of Dried Blood.

AMMONIFICATION OF DRIED BLOOD AS AFFECTED BY DEXTROSE.

Series Q.

Samples of soil containing an amount of dried blood equivalent to 155 mgs. of nitrogen were prepared in the usual way, and to these varying amounts of dextrose were added. The amounts of dextrose used and the mgs. of ammonia nitrogen found are recorded in the following table:

Soil Portion No.	(An amount of dried blood equi. to 155 mgs. N. used in each case.) Addition.	Water Added. cc.	AMMONIA N. RECOVERED. 7 days. mgs.	AMMONIA N. RECOVERED. Average. mgs.
1, 2	Nothing	20.	87.47 68.83	78.15
3, 4	0.1 gm. Dextrose	20.	74.58 75.28	74.93
5, 6	0.3 " "	20.4	71.97 83.64	77.80
7, 8	0.5 " "	20.7	78.76 77.72	78.24
9, 10	1.0 " "	21.5	70.22 68.65	69.43
11, 12	2.0 " "	23.5	58.72 58.55	58.63
13, 14	3.0 " "	24.5	48.09 40.08	44.08
15, 16	5.0 " "	27.5	16.55 16.55	16.55

When dried blood alone was used, 78.15 mgs. (average) of ammonia nitrogen were recovered. When .1, .3 and .5 gram of dextrose was added the amount of ammonia nitrogen was neither increased nor decreased to any great extent. With larger amounts of dextrose, 1, 2, 3 and 5 grams there was a gradual decrease in the amount of ammonia nitrogen. This is in agreement with results already reported[1], and with results from pot experiments reported by Hutchinson and Marr.[2] They found that when starch was applied at the rate of one ton per acre, the yield of barley was decreased 17.45%, and that an equivalent application of sucrose resulted in a decrease in yield of 31.2%. An examination of the soil showed a greatly increased growth of bacteria and molds. They found that in culture tests 2% of starch and dextrose increased the growth of bacteria and molds, but that mannitol did not produce this result.

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[1] Lipman and Brown, N. J. Sta. Reports 1908 and 1909.

[2] Changes induced by the addition of carbohydrates to soils. Inter. Cong. App. Chem. London (1909) Sect. VII. Abs. Expt. Sta. Record 25 (1911), No. 6.

Coleman,[1] on the other hand, has shown that nitrification was considerably increased in non-sterilized soils by the addition of small amounts (0.5%) of dextrose, the greatest increase being observed in the second and third weeks. Subsequently, the effect decreased and denitrification (due to organic matter) increased. He also reports that cane sugar, glycerine and lactose seemed to have a favorable effect on nitrification. With high percentages of water he found that dextrose was injurious rather than beneficial. In this connection it may be noted that Koch and Pettit[2] have called attention to the fact that in liquids and very wet soils from which oxygen is excluded the bacteria take their oxygen from the nitrates present in the soil and thus liberate nitrogen, but that in well-aerated soils this does not occur as the bacteria can then use the oxygen of the air.

As pointed out in previous reports, this decreased yield of ammonia in the presence of considerable quantities of carbohydrates must be attributed either to an inhibiting effect of the carbohydrates on ammonification or to conditions which encourage the growth of molds and acid producing bacteria, which, in turn, utilize, in their own growth, some of the ammonia produced.

The curve in the diagram accompanying series R shows very plainly the influence of dextrose on the ammonification of dried blood.

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[1] Investigations on Nitrification, L. C. Coleman (Centrl. Bakt., &c., 2 Abt., 20 (1908), Nos. 12-14, pp. 401-420; 15-17, pp. 484-513. Abs. Expt. Sta. Record 20 (1909), No. 6.

[2] (Centrl. Bakt., &c., 2, Abt. 26 (1910), Nos. 10-12.)

EFFECT OF VARYING AMOUNTS OF STARCH AND SACCHAROSE ON THE AMMONIFICATION OF DRIED BLOOD.

Series R.

Samples of soil containing an amount of dried blood equivalent to 155 mgs. of nitrogen were used. These were moistened as usual and kept in the incubator at the usual temperature for seven days. At the end of this period the nitrogen was determined. The amounts of starch and saccharose added and the nitrogen recovered are shown in the following table:

Soil Portion No.	Additions.	Water Added, including infusion.	AMMONIA N. RECOVERED.	
			7 days.	Average.
		cc.	mgs.	mgs.
1, 2	Nothing	20.00	68.83 73.19	71.01
3, 4	0.1 gm. Starch	20.00	76.67 66.04	71.35
5, 6	0.3 " "	20.30	74.93 80.33	77.63
7, 8	0.5 " "	20.60	77.72 77.19	77.45
9, 10	1.0 " "	21.50	55.41 56.63	56.02
11, 12	2.0 " "	23.00	40.60 39.38	39.99
13, 14	3.0 " "	24.5	31.19 22.65	26.92
15, 16	5.0 " "	27.20	4.88 5.23	5.05
17, 18	0.1 " Saccharose	20.00	83.29 84.16	83.72
19, 20	0.3 " "	20.30	83.99 87.30	85.64
21, 22	0.5 " "	20.6	93.05 95.84	94.44
23, 24	1.00 " "	21.5	85.03 81.72	83.37
25, 26	2.00 " "	23.00	54.46 58.90	57.68
27, 28	3.00 " "	24.5	43.99 43.99	43. 99
29, 30	5.00 " "	27.20	9.24 18.82	14.03

From this table it will be observed, in the case of the starch, that the amount of ammonia nitrogen recovered up to one-half gram of starch is slightly greater than the amount recovered from the blood alone, with a tendency to a slight increase with increased amounts of starch up to one-half gram.

This is in agreement with the work reported in series Q, and also with work reported from abroad,[1] where it has been shown that small amounts of starch and other carbohydrates appear to have a slight stimulating effect on ammonification. With one gram and more of starch there is a rather rapid decrease of ammonia nitrogen. The same is true of the saccharose, though in this case the yield of ammonia is decidedly greater throughout than with the starch.

Both starch and saccharose, in quantities above one gram, appear to influence, unfavorably, ammonia production in dried blood, and this effect is more pronounced with starch than with saccharose. We may here raise the question as to why the starch has a more depressing effect than the sugar, but here again the answer must be left for further investigation. The results with starch are, in the main, confirmatory of results reported in series N, R, S, U and V, 1909.[2]

The accompanying diagram of curves enables us to compare, more easily, the influence of dextrose, starch and saccharose on the ammonification of dried blood. (For dextrose, see series Q.)

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[1] l. c. series Q.

[2] Report Soil Chemist and Bacteriologist, N. J. Sta., 1909, p. 157 and following.

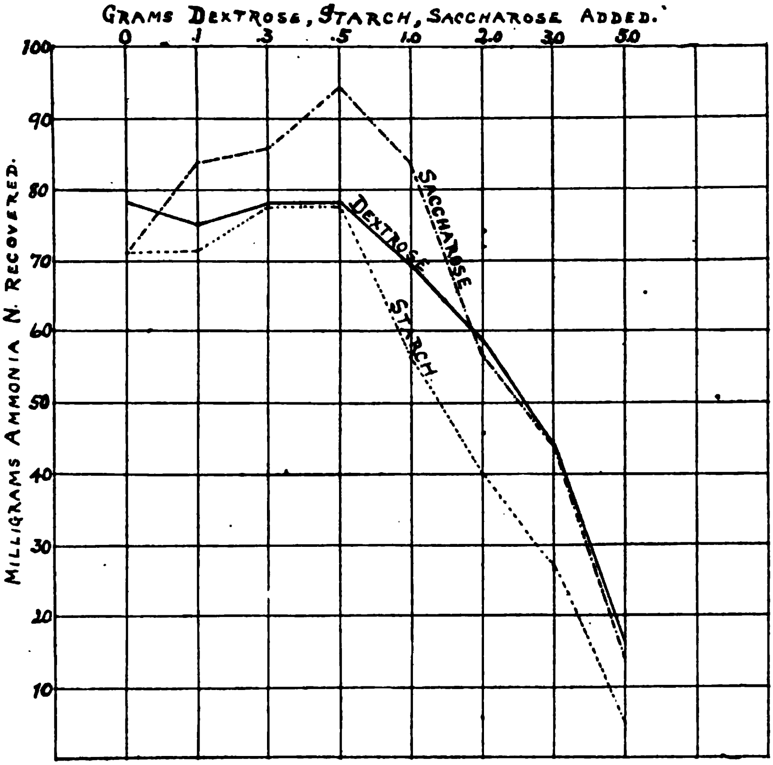

Fig. 3.

A comparison of the retarding effect of dextrose, starch and saccharose on the ammonification of dried blood.

AMMONIFICATION OF VEGETABLE SUBSTANCES IN THE PRESENCE OF DEXTROSE.

Series S.

For this series samples of soil were prepared in the usual way, though no dried blood was employed; instead different meals were used with and without dextrose. Samples thus prepared were placed in the incubator at 27°-28° C. for seven days. At the end of this period the ammonia nitrogen was determined.

The following table shows the kind and amount of meal used with and without dextrose and the amount of ammonia recovered:

SOIL PORTION NO.	Organic Materials Used.	Dextrose Added.	Water Added. cc.	Nitrogen in Material Used. mgs.	AMMONIA N. RECOVERED. 7 Days. mgs.	Average. mgs.
1, 2......	4.0 gms. Rice Flour	None....	24.00	46.4	1.39 1.22	1.30
3, 4......	4.0 " " "	2.0 gms..	26.00	46.4	1.22 1.39	1.30
5, 6......	4.0 " Corn Meal	None....	24.00	51.2	1.22 1.22	1.22
7, 8......	4.0 " " "	2.0 gms..	26.00	51.2	1.39 1.22	1.30
9, 10......	4.0 " Wheat Flour	None....	24.00	94.8	4.88 5.23	5.05
11, 12......	4.0 " " "	2.0 gms..	26.00	94.8	3.48 3.83	3.66
13, 14......	4.0 " Linseed Meal ...	None....	24.00	247.0	120.06 116.57	118.31
15, 16......	4.0 " " " ...	2.0 gms..	26.00	247.0	96.88 95.14	96.01
17, 18......	4.0 " Cowpea Meal ...	None....	24.00	156.8	51.23 49.49	50.36
19, 20......	4.0 " " " ...	2.0 gms..	26.00	156.8	33.11 30.32	31.71
21, 22......	4.0 " Soybean Meal ...	None....	24.00	245.6	133.65 131.21	132.43
23, 24......	4.0 " " " ...	2.0 gms..	26.00	245.6	109.78 106.29	108.03
25, 26......	4.0 " Cottonseed Meal..	None....	24.00	246.12	125.98 121.28	123.63
27, 28......	4.0 " " " ..	2.0 gms..	26.00	240.12	98.97 100.37	99.67

From this it will be seen that the amount of ammonia nitrogen recovered from rice flour and corn meal was about the same with the dextrose as without it. With the wheat flour, linseed meal, cowpea meal, soy bean meal and cottonseed meal, on the other hand, the amount of ammonia nitrogen recovered was invariably less when dextrose was used. With the exception of the rice flour, corn meal and wheat flour, the amount of nitrogen recovered is approximately proportional to the amount actually used.

The results obtained in this series are, in the main, in accord with results reported in an earlier paper,[1] and seem to further establish the importance of the carbon-nitrogen ratio in ammonification processes. It would appear that in the presence of compounds containing a relatively large proportion of nitrogeneous matter such as cottonseed meal, the bacteria are able to compete successfully with other micro-organisms, while in the presence of a relatively large proportion of readily decomposable carbohydrates, yeasts and molds develop rapidly and thus reduce the amount of available ammonia.

AMMONIFICATION OF VEGETABLE SUBSTANCES IN THE PRESENCE OF STARCH AND SACCHAROSE.

Series T.

For this series samples of soil were prepared as in series A, though without the addition of dried blood; instead of the blood, rice flour, wheat flour and different meals were used alone and with starch and saccharose. The samples thus prepared were incubated for 7 days, and the ammonia nitrogen determined at the end of this period. The amounts of material used and of starch and saccharose added and ammonia recovered are reported in the following table:

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[1] Report of Soil Chemist and Bacteriologist. N. J. Sta. Report. 1910.

AMMONIFICATION OF DRIED BLOOD AND COTTONSEED MEAL BY INFUSIONS FROM DIFFERENT LIME PLOTS (35-41).

Series 5.

In order to secure additional information on the ammonifying power of fresh and corresponding pasteurized infusion, the present experiment was carried out with soils derived from the lime plots at the College Farm. These plots are limed once in five years, according to the following plan:

35 Nothing.
36 One-half ton of non-magnesian lime per acre.
37 One ton non-magnesian lime per acre.
38 Two tons non-magnesian lime per acre.
39 One-half ton magnesian lime per acre.
40 One " " " " "
41 Two tons " " " "

Representative samples of soil from these plots were secured and infusions prepared by shaking, for five minutes, 100 gms. of soil with 200 cc. of sterile water. The infusion from each soil was divided into two portions, and one of them was Pasteurized by being heated to 80° C. for five minutes. The infusions in question were added to 100 gm. portions of standard soil containing 20 per cent. of pure quartz sand, and quantities of dried blood, or of cottonseed meal, equivalent to 155 mgs. of nitrogen. Optimum amounts of moisture were added to these soil portions previous to sterilization. These soil portions, kept in properly plugged Erlenmeyer flasks, were cooled after sterilization and inoculated in each case with 5 cc. portions of soil infusion. Ammonia determinations were made after an incubation period of 7 days. The following table shows the results secured:

With the exception of the rice flour and wheat flour, the amount of ammonia recovered was invariably less when starch and saccharose were added to the nitrogenous material; and with one exception, viz., the linseed meal, the amount was less with starch than with saccharose. This confirms results obtained with saccharose in series X of this report and with starch and saccharose in series R.

It will be observed that the proportion of ammonia nitrogen recovered from the linseed, cowpea, soy bean and cottonseed meals is materially greater than that recovered from the rice flour, corn meal and wheat flour. For example, had the nitrogen in the corn meal alone yielded ammonia in the same ratio as did the nitrogen in the linseed meal alone, the yield in the former case would have been 21.36 mgs. instead of 1.13 mgs. This is in agreement with work reported in an earlier paper.[1]

From the above results we are led to conclude that either the starch and saccharose in the quantities used have a depressing influence upon ammonification processes, or they make the conditions more favorable for the development of micro-organisms that use available ammonia. It would further seem that the rice flour, corn meal and wheat flour have, in themselves, an effect similar to that produced by the starch and saccharose.

INFLUENCE OF CARBOHYDRATES ON THE AMMONIFICATION OF DRIED BLOOD AND COTTONSEED MEAL.

Series U.

A mixture of 80 grams soil and 20 grams sand was prepared in the usual way. To the samples thus prepared, dried blood and cottonseed meal were added alone, and in combination with substances rich in carbohydrates. The mixtures were incubated as usual and the ammonia determined.

In the following table is found the arrangement of the series and the amounts of ammonia nitrogen recovered at the end of the seven day period:

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[1] Report of Soil Chemist and Bacteriologist, N. J. Sta., 1910, p. 149.

It will be observed that the sterilized dried blood, with no infusion, yielded 1.59 mgs. of nitrogen. With fresh infusion the average from the 7 plots was 64.73 mgs. of ammonia nitrogen, and with the Pasteurized infusions it was 60.17 mgs. The sterilized cottonseed meal, with no infusion, yielded 5.54 mgs. of nitrogen; with the fresh infusion the average from the 7 plots was 61.25 mgs. of nitrogen and with the Pasteurized infusions it was 56.39 mgs. of nitrogen. It is clear, therefore, that with both these organic materials more ammonia was recovered with the fresh than with the Pasteurized infusion. This may be readily understood when we consider that the Pasteurized infusion contained a much smaller number of bacteria than the fresh infusion. On the other hand, the results in question do not bear out Russell and Hutchinson's contention as to the part played by protozoa in depressing the activities of soil bacteria.

THE INFLUENCE OF STERILIZATION ON THE AMMONIFYING POWER OF SOILS.

Series 6.

Still further data on the relative efficiency of fresh and Pasteurized infusions used in sterile and non-sterile soils are recorded in the following pages.

The soil portions for this experiment were made as in Series A, and two grams of dried blood added to each. The infusion was made with 100 grams of soil to 200 cc. of water. Half of the soil samples were sterilized while the other half remained unsterilized. The samples were then incubated for 7 days in the usual way, and the ammonia nitrogen determined. The treatment given and the nitrogen recovered are indicated in the following table:

SOIL PORTION NO.	Infusion Added.	Treatment of Soil.	Sterilized Water Added.	AMMONIA N. RECOVERED.	
				7 Days.	Average.
			cc.	mgs.	mgs.
1, 2.....	None*	Sterilized	21.00	81.14 81.14	81.14
3, 4.....	0.1 cc. Fresh Soil Infusion.....	Sterilized	21.00	91.73 89.79	90.76
5, 6.....	0.5 " " " "	Sterilized	20.50	98.25 88.02	93.13
7, 8.....	1.0 " " " "	Sterilized	20.00	74.44 91.02	82.73
9, 10.....	3.0 " " " "	Sterilized	18.00	88.91 77.97	83.44
11, 12.....	5.0 " " " "	Sterilized	16.00	83.44 86.44	84.94
13, 14.....	10.0 " " " "	Sterilized	11.00	76.20 94.39	85.29
15, 16.....	0.1 " Pasteurized Soil Infusion	Sterilized	21.00	61.21 70.21	65.21
17, 18.....	0.5 " " " "	Sterilized	20.50	52.92 Lost	52.92
19, 20.....	1.0 " " " "	Sterilized	20.00	90.67 62.27	76.47
21, 22.....	3.0 " " " "	Sterilized	18.00	78.85 45.86	62.35
23, 24.....	5.0 " " " "	Sterilized	16.00	76.73 63.15	69.94
25, 26.....	10.0 " " " "	Sterilized	11.00	49.57 59.09	54.33
27, 28.....	None	Unsterilized ...	21.00	134.42 130.18	132.30
29, 30.....	0.1 cc. Fresh Soil Infusion.....	Unsterilized ...	21.00	123.66 121.54	122.60
31, 32.....	0.5 " " " "	Unsterilized ...	20.50	128.24 121.89	125.06
33, 34.....	1.0 " " " "	Unsterilized ...	20.00	114.66 124.19	119.42
35, 36.....	3.0 " " " "	Unsterilized ...	18.00	123.66 124.54	124.10
37, 38.....	5.0 " " " "	Unsterilized ...	16.00	117.13 117.84	117.48
39, 40.....	10.0 " " " "	Unsterilized ...	11.00	123.48 127.18	125.33
41, 42.....	0.1 " Pasteurized Soil Infusion	Unsterilized ...	21.00	118.54 121.89	120.21
43, 44.....	0.5 " " " "	Unsterilized ...	20.50	106.90 122.95	114.92
45, 46.....	1.0 " " " "	Unsterilized ...	20.00	125.95 128.95	127.45
47, 48.....	3.0 " " " "	Unsterilized ...	18.00	121.89 121.54	121.71
49, 50.....	5.0 " " " "	Unsterilized ...	16.00	121.36 121.72	121.54
51, 52.....	10.0 " " " "	Unsterilized ...	11.00	120.66 129.12	124.89

* Inoculated through error.

In arranging the experiment it was intended to leave soil portions 1 and 2 uninoculated. Through an error a quantity of soil infusion was added also to these soil portions. This error does not affect, however, the value of the data secured. It will be observed in the examination of these data that the sterilized soils produced less ammonia than the unsterilized soils. It will be observed, further, that where the soil was sterilized the addition of fresh infusion was more effective in providing for an accumulation of ammonia than was the addition of corresponding amounts of Pasteurized infusion. Here again we are unable to confirm the claims made by Russell and Hutchinson as to the influence of protozoa in modifying the amount of work done by decay bacteria.

As to the quantities of fresh and Pasteurized infusion, added to sterile soil, we are unable to detect any marked difference in their action. Where fresh soil infusion was used 5 and 10 cc. quantities produced but little more ammonia than 1 and 3 cc. quantities and they also produced less ammonia than one-tenth and five-tenths cc. quantities. In the case of the Pasteurized infusion, there is no evidence to show that the larger quantity of inoculating material was more efficient than smaller quantities in promoting ammonification. Comparing, similarly, the results secured in the unsterilized soil portions, we note that the influence of the inoculating material was of slight moment. The bacteria present in the soil itself were capable of causing an apparently maximum amount of change under the conditions of the experiment. Hence, the fresh infusion was not superior to Pasteurized infusion, as was true in the case of the sterile soils. For the same and other reasons the varying amounts of infusion added did not produce corresponding variations in the amounts of ammonia accumulated in the several soil portions. It is safe to conclude, therefore, that in sterile soils Pasteurized infusion is less effective than non-Pasteurized for the production and accumulation of ammonia. In the non-sterile soils, on the other hand, the influence of either fresh or Pasteurized infusion is of secondary importance.

THE EFFECT OF DRYING ON THE AMMONIFYING POWER OF SOILS.

Series 7.

It was already observed by Rahn[1] that air dried soil is more effective in causing ammonification in peptone solutions than are corresponding amounts of fresh soil. This fact may be explained in part by the chemical changes caused in the soil by the process of air drying. However, Russell and Hutchinson are inclined to ascribe the greater ammonifying efficiency of air dried soil to the injurious influence of air drying on the protozoa.

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[1] *Centr. für Bakteriologie, 1908, II Bd. 20, S. 38.*

It is not intended to prove by the present experiment that protozoa are, or are not, the cause of the slighter ammonifying efficiency of fresh soil. The clearing up of this question may be left to other experiments properly planned. In the present instance it is merely intended to supply further data on the influence of air drying on the ammonifying efficiency of soil.

A quantity of soil was placed in a covered dish and set aside in a cool place. A similar portion was spread out and dried for five days (the moisture in this soil was 20 per cent.). One hundred gram portions of air dry and 125 gram portions of moist soil were taken and to each was added 0.5 gram calcium carbonate, and an amount of dried blood or cottonseed meal, equivalent to 155 mgs. of nitrogen. After adding sufficient water to the air dry portions the samples were incubated for seven days in the usual way and the ammonia determined at the end of this period.

The results are reported in the following table:

Soil Portion No.	Special Treatment.	Water Added.	Ammonia N. Recovered.	
		cc.	7 days. mg.	Average. mg.
1, 2.....	125 gms. Fresh Soil + 155 mg. N. in Dried Blood	3	74.97 73.56	74.26
3, 4.....	125 gms. Fresh Soil + 155 mg. N. in Cottonseed Meal	5	49.57 51.16	50.36
5, 6.....	100 gms. Air Dry Soil + 155 mg. N. in Dried Blood	28	79.38 81.14	80.26
7, 8.....	100 gms. Air Dry Soil + 155 mg. N. in Cottonseed Meal	30	60.68 62.27	61.47

From the table it is seen that the air dry soil yielded slightly more nitrogen with both the blood and cottonseed meal, than did the moist soil. This evidence is, therefore, in accord with the facts already noted.

CONDITIONS AFFECTING THE AVAILABILITY OF NITROGEN COMPOUNDS IN VEGETATION EXPERIMENTS.

THE UTILIZATION OF NITROGEN BY CROPS IN THE PRESENCE OF DEXTROSE.

Experiment 1.

Laboratory experiments have demonstrated[1] that in the presence of soluble carbohydrates, the accumulation of ammonia from peptone was depressed. To carry the work a step further it seemed worth while to determine by pot tests what effect, if any, these carbohydrates would have on the utilization of nitrogen by a growing crop. The experiment was carried out in pots containing 14 pounds of shale soil and six pounds of sand. To each pot was added 5 grams acid phosphate, 3 grams potassium sulphate and 10 grams prepared lime. The moisture content was brought to 14-18 per cent., and 5 or 6 kernels of corn planted in each pot. The yield of dry matter and total nitrogen are indicated in the following table:

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[1] Lipman and Brown, N. J. Sta. Report, 1908, pp. 100–105.

NO. OF POT.	Treatment.	Dry Matter. gms.	Per cent. N.	Total N. gms.	Total N. Average. gms.
23, 24	3 gms. Dried Blood	31	1.51	0.47	0.45
		32	1.36	0.44	
25, 26	3 " " " 1 gm. Dextrose	37	1.23	0.46	0.44
		40	1.06	0.42	
27, 28	3 " " " 3 gms. "	37	1.07	0.40	0.39
		34	1.13	0.38	
29, 30	3 " " " 5 " "	33	1.18	0.39	0.38
		32	1.15	0.37	
31, 32	2 " Nitrate of Soda	36	1.36	0.49	0.48
		34	1.41	0.48	
33, 34	2 " " " " 1 gm. Dextrose	33	1.42	0.47	0.45
		34	1.26	0.43	
35, 36	2 " " " " 3 gms. "	33	1.41	0.47	0.43
		30	1.32	0.40	
37, 38	2 " " " " 5 " "	33	1.19	0.39	0.41
		25	1.72	0.43	
39, 40	1.5 " Sulphate of Ammonia	35	1.23	0.43	0.45
		40	1.18	0.47	
41, 42	1.5 " " " " 1 gm. Dextrose	36	1.17	0.42	0.40
		24	1.61	0.39	
43, 44	1.5 " " " " 3 gms. "	38	1.11	0.42	0.50
		35	1.66	0.58	
45, 46	1.5 " " " " 5 " "	31	1.17	0.36	0.39
		39	1.10	0.43	

With 3 grams of dried blood alone the total yield of nitrogen was .45 gram, while with the blood and 1, 3 and 5 grams dextrose there was a gradual decrease to .38 gram. With 2 grams nitrate of soda the yield of nitrogen was .48 gram, with a gradual decrease to .41 gram with 1, 3 and 5 grams dextrose. With 1.5 gms. of sulphate of ammonia the nitrogen yield was .45 gram with a slight decrease when 1 gram of dextrose was added and an increase with 3 grams, and finally a decrease to .39 gram with 5 grams of dextrose. While the differences are not great, they indicate that the dextrose had a slightly depressing effect on nitrogen assimilation, thus confirming results obtained by the ammonification method, and also the vegetation experiments of Hutchinson and Marr, reference to which has already been made.

THE AVAILABILITY OF NITROGEN IN DRIED BLOOD, TANKAGE, DRIED FISH AND AMMONIATES.

Experiment 2.

This work was carried out in earthenware pots, with 20 pounds of pure quartz sand. Each pot was inoculated with 50 cc. of soil infusion (25 grams fertile soil). To each was also added 4 grams acid phosphate, 2 grams potassium sulphate, 0.5 gram magnesium sulphate and 0.2 gram ferric sulphate.

The pots were tared to 10 pounds and the moisture brought to 10 per cent. making a total weight of 33 pounds. The organic fertilizers were figured on the basis of nitrate of soda equivalent to 155 mgs. of nitrogen. The pots were arranged in pairs, and 20 grains of barley planted in each. The following table shows the special treatment given, together with the dry matter and nitrogen recovered:

NO. OF POT.	Special Fertilizer Treatment.	Yield of Dry Matter. gms.	N. %	Total N. mgs.	Average N. mgs.	Increase Over Blank. mgs.	N. Recovered. %
1, 2	Nothing	2.7	1.072	28.94	28.94	....	....
		2.7	1.072	28.94			
3, 4	1 gm. Nitrate of Soda	10.7	1.445	154.61	149.80	120.86	77.97
		10.5	1.381	145.00			
5, 6	0.7820 gms. Ammonium Sulphate	11.5	1.118	128.57	132.71	103.77	66.95
		11.5	1.190	136.87			
7, 8	1.2233 " Blood No. 1	8.9	1.127	100.50	96.66	67.72	43.69
		7.8	1.190	92.82			
9, 10	1.1932 " " " 6	11.0	1.027	112.97	104.52	75.58	48.76
		7.5	1.281	96.07			
11, 12	1.1968 " " " 10	9.5	1.208	114.70	108.50	79.56	51.33
		9.0	1.136	102.24			
13, 14	2.0367 " " " 23	5.8	1.127	65.37	69.44	40.50	26.13
		6.8	1.081	73.51			
15, 16	1.1381 " " " 51	8.7	1.063	92.48	98.57	69.63	44.92
		9.0	1.163	104.67			
17, 18	1.6939 " " " 66	6.2	1.063	65.90	68.26	39.32	25.37
		6.7	1.054	70.62			
19, 20	1.2223 " " " 78	9.2	1.099	101.11	96.88	67.94	43.83
		8.5	1.090	92.65			
21, 22	1.5316 " " " 162	9.3	0.990	92.91	88.53	59.59	38.44
		8.5	0.990	84.15			
23, 24	2.2929 " Tankage No. 8	8.5	0.945	80.32	77.96	49.02	31.63
		7.5	1.008	75.60			
25, 26	2.1985 " " " 14	9.0	0.999	89.91	87.06	58.12	37.50
		8.2	1.027	84.21			
27, 28	3.3842 " " " 16	7.5	0.999	74.92	70.38	41.44	26.74
		6.3	1.045	65.84			
29, 30	2.2660 " " " 48	7.2	0.936	67.39	76.53	47.59	30.70
		8.5	1.008	85.68			
31, 32	2.0450 " " " 58	7.0	0.999	69.93	67.66	38.72	24.98
		6.0	1.090	65.40			
33, 34	3.3264 " " " 59	6.0	0.908	54.48	55.69	26.75	17.26
		5.8	0.981	56.90			
35, 36	2.6770 " " " 70	7.7	0.999	76.92	74.19	45.25	29.19
		7.0	1.021	71.47			
37, 38	2.6541 " " " 86	6.2	1.063	65.91	66.92	37.98	24.50
		6.8	0.999	67.93			
39, 40	3.2157 " " " 127	8.7	1.027	89.36	91.82	62.88	40.57
		9.2	1.027	94.28			

NO. OF POT.	Special Fertilizer Treatment.	Yield of Dry Matter. gms.	N. %	Total N. mgs.	Average N. mgs.	Increase Over Blank. mgs.	N. Recovered. %
41, 42	2.9026 gms. Tankage No. 128	6.5	0.981	63.76	66.22	37.28	24.05
		7.0	0.981	68.67			
43, 44	Nothing	2.6	0.908	23.61	23.08	....	....
		2.3	0.981	22.56			
45, 46	1.9874 gms. Fish No. 24	7.5	1.127	84.52	84.42	55.48	35.79
		7.8	1.081	84.32			
47, 48	1.9570 " " " 36	8.8	1.063	93.54	92.33	63.39	40.90
		8.5	1.072	91.12			
49, 50	2.6006 " " " 37	8.8	1.036	91.17	94.59	65.65	42.35
		9.3	1.054	98.02			
51, 52	1.7673 " " " 44	9.7	1.018	98.74	87.53	58.59	37.80
		8.0	0.954	76.32			
53, 54	2.5790 " " " 85	9.5	1.018	96.71	94.55	65.61	42.33
		8.7	1.054	92.40			
55, 56	1.9254 " " " 111	8.3	1.108	91.96	89.71	60.77	39.20
		7.7	1.136	87.47			
57, 58	1.9375 " " " 147	8.2	1.027	84.21	88.50	59.56	38.43
		8.3	1.118	92.79			
59, 60	1.9871 " " " 150	8.5	1.045	88.82	87.52	58.58	37.79
		7.3	1.181	86.21			
61, 62	2.8336 " " " 152	9.0	1.021	91.89	98.85	69.91	45.23
		11.2	0.945	105.82			
63, 64	1.8810 " " " 161	8.6	1.108	95.29	92.65	63.71	41.10
		7.8	1.154	90.01			
65, 66	1.1127 " " " 40	9.0	1.063	95.67	93.01	64.07	41.34
		8.5	1.063	90.35			
67, 68	1.5045 " " " 45	8.5	1.148	97.58	102.34	73.40	47.36
		9.0	1.190	107.10			

From the study of this table it is seen that there is a wide difference between the yield of dry matter from the pots that received nothing, and those that were fertilized. Those receiving sulphate of ammonia gave the greatest yield of dry matter, while those receiving nitrate of soda showed the highest percentage of nitrogen recovered, 77.97. Pots 33 and 34 fertilized with tankage No. 59 gave the lowest yield of dry matter and the lowest percentage of nitrogen recovered.

Comparing the percentage of nitrogen recovered where nitrate of soda and sulphate of ammonia were used, with the average of the pots where dried blood, tankage, fish and ammoniates were used, we have the following:

Nitrate of soda		77.97 %
Sulphate of ammonia		66.95 "
Blood	(average, 8 samples)	40.31 "
Tankage	(average, 10 ")	28.71 "
Fish	(average, 10 ")	40.09 "
Ammoniates	(average, 2 ")	44.35 "

The tankage stands lowest in the list, while of the other organic materials, the blood, fish and ammoniates do not differ greatly.

THE INFLUENCE OF FINENESS OF DIVISION ON THE AVAILABILITY OF NITROGEN IN DRIED BLOOD.

Experiment 3.

For this work earthenware pots painted inside and out were used. In these was placed 20 pounds of white sand inoculated with 50 cc. of soil infusion, equivalent to 25 gms. soil. Each pot received 4 gms. acid phosphate, 2 gms. potassium sulphate, 10 gms. calcium carbonate (precipitated chalk), 0.5 gm. magnesium sulphate and 0.2 gm. ferric sulphate. The pots were tared to 10½ pounds, and the moisture brought to 11 per cent., making a total of 33 pounds. In each was planted 20 grains of barley.

In the following table is shown the special fertilizer treatment given and the weight of dry matter, and nitrogen recovered:

NO. OF POT.	Special Fertilizer Treatment. (155 mgs. of N. used.)	Yield of Dry Matter. gms.	N. %	Total N. mgs.	Average N. mgs.	Increase Over Blank. mgs.	Nitrogen Recovered. %
1, 2	Nothing	5.5 6.0	0.966 0.949	53.13 56.94	55.03	....	....
3, 4	1.5930 gms. original sample	8.5 8.0	1.153 0.966	97.00 77.28	87.14	32.11	20.71
5, 6	1.5515 " through 1 mm. sieve	9.8 9.0	1.002 1.028	98.20 92.52	95.36	40.33	26.01
7, 8	1.5048 " " ½ " "	8.8 9.0	1.082 1.188	95.22 106.92	101.07	46.04	29.70
9, 10	1.4818 " " ¼ " "	7.0 11.8	1.232 1.179	86.24 139.12	112.68	57.65	37.19
11, 12	1.4932 " " 100-mesh "	10.5 10.0	1.516 1.170	159.18 117.00	138.09	83.06	53.58
13, 14	1.1577 " Swift's Sol. Blood Flour	11.0 10.5	1.250 1.082	137.50 113.61	125.55	70.52	45.49
15, 16	1.3500 " Swift's Con. Tank	9.2 10.0	1.099 1.419	101.11 141.90	121.50	66.47	42.88

These results indicate clearly that the fineness of division does have an influence upon the availability. With the original sample of blood 20.71 per cent. of the nitrogen is recovered; with the other samples, all of which are finer, the percentage ranges from 26.01 for the sample passing through the 1 mm. sieve, to 53.58 for that passing through the 100 mesh sieve. The greatest amount of dry matter was obtained where Swift's soluble blood flour was used, and the next highest with the blood passing the 100 mesh sieve.

THE INFLUENCE OF NON-MAGNESIAN AND MAGNESIAN LIME ON THE UTILIZATION OF NITROGEN IN DRIED BLOOD AND COTTONSEED MEAL.

Experiment 4.

Loew[1] has shown that magnesium salts in the soil, in great excess over lime, are poisonous to plants. He cites an instance where an injurious action was observed with the limestone from quarries near Belvidere, N. J., while other limestones from near Oxford (some distance away) showed very beneficial effects on the same field. On subjecting the two samples to analysis it was found that the injurious limestone contained 38-42 per cent. of magnesium carbonate, while the beneficial limestone contained not quite 1 per cent. of this material. Loew[2] further shows that this injurious effect may be, to some extent, counteracted by the use of an excess of lime with the magnesia.

It was to test the efficiency of the two forms of limestone with especial reference to the utilization of nitrogen in dried blood and cottonseed meal that this experiment was undertaken.

The tests were carried out in earthenware pots each holding 20 pounds of pure white sand. To this was added 4 gms. acid phosphate, 2 gms. potassium sulphate, 0.5 gm. magnesium sulphate and 0.2 gm. ferric sulphate. The pots were tared to weigh 10 pounds and the moisture brought to 10 per cent. making a total of 32 pounds.

Twenty barley seeds were planted in each pot. The pots were arranged in pairs and the special treatment given each, with the yield of barley (dry matter), are given in the following table:

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[1] U. S. D. A. Bureau of Plant Industry, bulletin No. 1.

[2] l. c.

No. OF POT.	Yield of Dry Matter. gms.	Average. gms.	SPECIAL TREATMENT.
1, 2	11.2 12.7	11.9	5 gms. dried blood, nothing.
3, 4	12.3 14.8	13.5	" " " 5 gms. calcium carbonate (precip. chalk).
5, 6	10.8 10.5	10.6	" " " 20 " " " " "
7, 8	11.5 12.7	12.1	" " " 50 " " " " "
9, 10	10.0 9.2	9.9	" " " 5 " magnesium carbonate.
11, 12	None.	....	" " " 20 " " "
13, 14	None.	....	" " " 50 " " "
15, 16	13.2 16.3	14.7	" " " 2½ " calcium carbonate, " " " 2½ " magnesium carbonate.
17, 18	2.3 12.2	7.2	" " " 10 " calcium carbonate. " " " 10 " magnesium carbonate.
19, 20	None.	....	" " " 25 " calcium carbonate. " " " 25 " magnesium carbonate.
21, 22	13.5 11.5	12.5	" cottonseed meal, nothing.
23, 24	12.5 9.0	10.7	" " " 5 gms. calcium carbonate.
25, 26	9.5 11.5	10.5	" " " 20 " " "
27, 28	8.5 8.7	8.6	" " " 50 " " "
29, 30	5.5 6.2	5.8	" " " 5 " magnesium carbonate.
31, 32	None.	....	" " " 20 " " "
33, 34	None.	....	" " " 50 " " "
35, 36	9.5 7.5	8.5	" " " 2½ " calcium carbonate. " " " 2½ " magnesium carbonate.
37, 38	1.7 4.2	2.9	" " " 10 " calcium carbonate. " " " 10 " magnesium carbonate.
39, 40	None.	....	" " " 25 " calcium carbonate. " " " 25 " magnesium carbonate.

A study of this table reveals the fact that when dried blood was used with the special treatment the average yield from the various pots was less than the check in every case except three, these exceptions being with 5 and 50 gms. calcium carbonate and with 2½ gms. calcium carbonate and 2½ gms. of magnesium carbonate, where the maximum yield was obtained. This result may be due to the fact that the amount of magnesia present is so small as to have no injurious effect, or to the counteracting influence of the lime. It would appear that the lime did possibly have this counteracting effect where 10 grams of each were used, for with 20 grams of the magnesium carbonate the crop was a total failure, while with 10 grams of each the yield was 7.2 grams.

The yield was slightly depressed with 5 gms. magnesium carbonate and with 20 to 50 gms. of this material the crop was an entire failure. With 10 gms. of calcium carbonate and 10 gms. magnesium carbonate the yield was much depressed, while with 25 gms. of each the crop was again a failure. Since the calcium carbonate alone increased the yield in two cases, and had only a slight depressing effect in the third, it seems clear that the magnesium carbonate is the cause of the decreasing yield and failures. Five grams and more of this material had this effect.

With the cottonseed meal none of the pots yielded an average equal to the average obtained from the check pots. The calcium carbonate appears to have slightly depressed the yield, while the magnesium carbonate, in quantities of 10 gms. and over, practically ruined the crop. Here, as with the dried blood, the magnesium carbonate in quantities of 5 gms. and over, seems to have had a distinctly poisonous effect. This effect appears when it is used alone and in combination with calcium carbonate, though again where the two are used together in moderate amounts the lime seems possibly to have somewhat counteracted the injurious effects of the magnesia.

Experiment 5.

This series was planned as a check upon Experiment 4. The sand, however, in the first section was replaced by 20 pounds of soil, and in the second section a mixture of equal parts of soil and yellow sand were used. The dried blood and minerals were used, and barley planted as in Experiment 4. The following table shows the special treatment and yield of barley for each pot:

No. OF POT.	Yield of Dry Matter. gms.	Average. gms.	SPECIAL TREATMENT.	
1, 2........	7.5 7.0	7.2	5 gms. dried blood, nothing.	20 lbs. soil.
3, 4........	10.5 9.5	10.0	" " " 5 gms. calcium carbonate.	
5, 6........	12.5 10.8	11.6	" " " 20 " " "	
7, 8........	14.0 14.0	14.0	" " " 50 " " "	
9, 10........	12.5 13.8	13.1	" " " 5 " magnesium "	
11, 12........	12.5 11.8	12.1	" " " 20 " " "	
13, 14........	2.5 5.0	3.7	" " " 50 " " "	
15, 16........	13.2 14.0	13.6	" " " 2½ " " " " " " 2½ " calcium "	
17, 18........	14.0 12.0	13.0	" " " 10 " " " " " " 10 " magnesium "	
19, 20........	13.2 13.8	13.5	" " " 25 " " " " " " 25 " calcium "	
21, 22........	12.5 12.5	12.5	" " " 5 " " "	10 lbs. soil, 10 lbs. yellow sand.
23, 24........	13.8 13.0	13.4	" " " 20 " " "	
25, 26........	15.5 13.0	14.2	" " " 50 " " "	
27, 28........	13.0 12.5	12.7	" " " 5 " magnesium "	
29, 30........	11.0 13.5	12.2	" " " 20 " " "	
31, 32........	0.5 0.5	0.5	" " " 50 " " "	
33, 34........	13.0 13.0	13.0	" " " 2½ " " " " " " 2½ " calcium "	
35, 36........	13.5 15.0	14.2	" " " 10 " " " " " " 10 " magnesium "	
37, 38........	5.0 12.0	8.5	" " " 25 " " " " " " 25 " calcium "	
39, 40........	14.0 13.0	13.5	" " " nothing.	

These results are not entirely in agreement with the results secured in Experiment 4. With the soil alone the magnesium carbonate, for example, does not appear to depress the yield materially until the 50 gm. portion has been reached. Here we have only 3.7 gms. dry matter as against 14 gms. with 50 gms. of calcium carbonate. With 25 gms. of magnesium carbonate and 25 gms. of calcium carbonate the yield is almost as much as with 50 gms. of calcium carbonate, indicating again that the lime possibly did have a counteracting effect. With the mixture of sand and soil the highest yield, 14.2 gms., is reached with 50 gms. of calcium carbonate and, also, with 10 gms. of calcium carbonate and 10 gms. of magnesium carbonate, again showing the possible beneficial effects of the lime in connection with the magnesia. In Experiment 4, it will be remembered, the yield was materially depressed by this combination.

From the results secured in Experiments 4 and 5 it would seem that for barley calcium carbonate, even in excessive amounts, does not have an injurious influence upon the utilization of the nitrogen of dried blood in the sand, or the soil, and it may not be amiss to call attention here to the very large amount of calcium carbonate that the plant will stand without showing injury therefrom. With cottonseed meal in the sand the yield is slightly depressed. Magnesium carbonate in large amounts unquestionably does have an injurious effect, both with the sand and soil, but the injurious effect is decidedly more pronounced with the sand than with the soil, and somewhat more pronounced with the mixture of sand and soil than with the soil alone. It is entirely probable that small amounts of magnesian lime in the soil may have a stimulating effect upon plant growth. The better results obtained where the magnesium carbonate was used with the soil, and sand and soil, may possibly be attributed to the fact that the soil naturally carries enough lime to partially, at least, counteract the added magnesia.

But, whatever the reason, practical experience is in entire agreement with the view that magnesian lime is more likely to prove injurious on sandy soils.

THE INFLUENCE OF DEXTROSE ON THE AVAILABILITY OF NITROGEN.

Experiment 6.

The work was carried on in earthenware pots holding 20 pounds of white quartz sand. To each pot was added 4 grams acid phosphate, 3 grams potassium sulphate, 5 grams non-magnesian lime, 0.5 gram magnesium sulphate and 0.2 gram ferric sulphate. The pots were tared to 10 pounds and water added to bring the moisture to 12 per cent., making the total weight 32 pounds. Soil infusion was added and corn planted in each pot.

The arrangement of the series and the yield of dry matter and nitrogen are shown in the following table:

NO. OF POT.	Special Treatment.	Dry Matter. gms.	Nitrogen. %	Total N. mgs.	Increase Over Check. mgs.	Total N. Recovered. %
1, 2	Nothing	2.0	0.647	13.0	....	....
		2.0	0.657	13.0		
3, 4	1 and 2 gms. $NaNO_3$ respectively	14.0	0.697	98.0	85.0	54.8
		22.0	0.871	192.0	179.0	57.7
5, 6	.745 and 1.490 gms. $(NH_4)_2SO_4$ respectively	16.0	0.608	97.0	84.0	54.2
		23.0	0.798	183.0	170.0	54.8
7, 8	1.093 and 2.186 gms. Blood E "	9.0	0.647	58.0	45.0	29.0
		14.0	0.713	100.0	87.0	28.1
9, 10	Nothing, 5 gms. Dextrose	1.0	0.773	8.0	....	....
		1.0	0.674	7.0	....	....
11, 12	1 and 2 gms. $NaNO_3$, 5 gms. Dextrose	12.0	0.552	66.0	58.5	37.7
		22.0	0.667	147.0	139.5	45.0
13, 14	.745 and 1.490 gms. $(NH_4)_2SO_4$, 5 gms. Dextrose	12.0	0.592	71.0	63.5	41.0
		24.0	0.658	158.0	150.5	48.5
15, 16	1.093 and 2.186 gms. Blood E, 5 " "	7.0	0.575	40.0	32.5	21.0
		16.0	0.602	96.0	88.5	28.5
17, 18	Nothing, 10 gms. Dextrose	2.0	0.838	16.8	....	....
		2.0	0.871	17.4	....	....
19, 20	1 and 2 gms. $NaNO_3$, 10 gms. Dextrose	9.0	0.584	53.0	35.9	23.2
		22.0	0.628	138.0	120.9	30.0
21, 22	.745 and 1.490 gms. $(NH_4)_2SO_4$, 10 gms. Dextrose	7.0	0.625	44.0	26.9	17.4
		23.0	0.681	157.0	139.9	45.1
23, 24	1.093 and 2.186 gms. Blood E, 10 " "	6.0	0.635	38.0	20.9	13.5
		13.0	0.651	85.0	67.9	21.9

From the nitrate of soda alone there was recovered 54.8 and 57.7 per cent. nitrogen, respectively; from the sulphate of ammonia 52.2 and 54.8 per cent., and from the dried blood 29.0 and 28.1 per cent. In each case the recovery is very nearly the same with the 1 gram as with the 2 gram portions. When 5 grams of dextrose was used with these materials, the amount of ammonia recovered was distinctly less and with 10 grams of dextrose it was still less, falling from 29 per cent. with 1 gram of dried blood and no dextrose, to 13.5 per cent. with the same amount of blood and 10 grams of dextrose. It is of interest to note that both the 5 and 10 gram portions of dextrose had a less depressing effect with the two gram portions of fertilizer than with the one gram portion. This is true of all three of the materials, and the difference is greater with 10 grams of dextrose than with 5 grams, the average difference with 5 grams being 7.4 and with 10 grams 17.3.

It is evident, also, that the dextrose had a depressing effect on the yield of dry matter. The following tabular statement of total dry matter and nitrogen and average per cent. nitrogen recovered, from the three divisions, will perhaps make the foregoing statements clearer:

SUMMARY—FERTILIZED POTS.

No.	TREATMENT.	Total Dry Matter. gms.	Total N. mgs.	Average Per Cent. N. Recovered.
3– 8	No dextrose	98	728	46.43
11–16	5 gms. dextrose	93	578	39.95
19–24	10 " "	80	515	26.68

These results further confirm work reported earlier in this paper and also the work of Hutchinson and Marr previously cited.

THE INFLUENCE OF MECHANICAL COMPOSITION OF THE SOIL ON THE AVAILABILITY OF NITRATE OF SODA AND DRIED BLOOD.

Experiment 7.

In an earlier paper on the ammonification of dried blood, as affected by the mechanical condition of the soil,[1] it was shown by laboratory tests that increasing proportions of sand led, gradually, to a decreasing accumulation of ammonia, and it seemed worth while to follow this work up with cylinder tests, using both nitrate of soda and dried blood.

For this work typical red shale soil that had not been under cultivation, was selected. This was screened to remove stones, and was then mixed with sand in varying proportions as indicated in the accompanying diagram. In addition to the sand and shale there was added to each cylinder 38 gms. precipitated chalk, 20 gms. acid phosphate, 5 gms. potassium chloride, 5 gms. potassium sulphate and 2 gms. C. P. magnesium carbonate.

The rotation, which is for five years, is corn, oats, wheat and timothy. Each group of six cylinders is set off into three pairs, and each of the three pairs of a group receives a different fertilizer treatment, which treatment, however, is common to all the groups. Thus the first and second cylinders of any group receive no fertilizer, the third and fourth receive 10 grams of nitrate of soda and the fifth and sixth dried blood equivalent to the 10 gms. of nitrate of soda.

In the following table is reported the weight of dry matter and nitrogen in the total crop, and the percentage of nitrogen recovered:

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[1] Report of Soil Chemist and Bacteriologist, N. J. Expt. Sta., 1910, p. 90.

SUB-GROUP.		Net Weight Dry Matter. gms.	N. ≴	Total N. gms.	Average N. gms.	Average Increase Over Check Plot. gms.	Nitrogen Recovered. ≴	Relative Availability.
A	1	273	.408	1.114				
	2	234	.416	.973	1.043	....	....	....
	3	401	.444	1.780				
	4	403	.491	1.979	1.880	.837	54.4	100.0
	5	354	.424	1.501				
	6	367	.436	1.600	1.550	.507	32.9	60.0
B	1	238	.509	1.211				
	2	239	.376	.899	1.055	....	....	....
	3	389	.420	1.634				
	4	375	.483	1.811	1.722	.667	43.3	100.0
	5	334	.423	1.413				
	6	332	.383	1.272	1.342	.287	18.6	43.0
C	1	242	.376	.910				
	2	344	.616	2.110	1.524	....	....	....
	3	405	.420	1.701				
	4	404	.440	1.778	1.740	.216	14.0	100.0
	5	363	.528	1.917				
	6	326	.436	1.421	1.669	.145	9.4	67.0
D	1	197	.436	.859				
	2	190	.476	.904	.881	....	....	....
	3	358	.508	1.819				
	4	345	.499	1.721	1.770	.889	57.7	100.0
	5	288	.449	1.203				
	6	285	.525	1.496	1.394	.513	33.3	58.0
E	1	218	.417	.909				
	2	212	.420	.890	.899	....	....	....
	3	410	.656	2.690				
	4	345	.462	1.594	2.142	1.243	80.7	100.0
	5	293	.479	1.403				
	6	362	.531	1.922	1.662	.763	49.5	61.3
F	1	208	.466	.969				
	2	233	.462	1.076	1.022	....	....	....
	3	415	.492	2.042				
	4	346	.420	1.453	1.747	.725	47.1	100.0
	5	277	.443	1.227				
	6	305	.433	1.321	1.274	.252	16.4	34.8
G	1	118	.403	.476				
	2	130	.413	.537	.506	....	....	....
	3	217	.476	1.033				
	4	260	.449	1.167	1.100	.594	38.6	100.0
	5	198	.410	.812				
	6	207	.433	.896	.854	.348	22.6	58.5
H	1	97	.479	.465				
	2	100	.476	.470	.470	....	....	....
	3	152	.432	.657				
	4	230	.410	.943	.800	.330	21.4	100.0
	5	191	.387	.739				
	6	188	.423	.795	.767	.297	19.3	90.2
I	1	72	.460	.331				
	2	63	.510	.321	.326	....	....	....
	3	181	.420	.760				
	4	161	.373	.600	.680	.354	23.0	100.0
	5	159	.427	.679				
	6	152	.390	.593	.636	.310	20.1	87.4
J	1	39	.520	.203				
	2	35	.553	.194	.198	....	....	....
	3	82	.423	.347				
	4	68	.473	.322	.334	.136	8.83	100.0
	5	97	.440	.427				
	6	136	.450	.612	.520	.322	20.9	236.7

PLAN OF EXPERIMENT.

Series.	Arrangement of Cylinders.	Soil.	Treatment.
A	① ② ③ ④ ⑤ ⑥	Shale soil	1, 2, nothing. 3, 4, 10 gms. nitrate soda. 5, 6, 18.132 gms. dried blood.
B	① ② ③ ④ ⑤ ⑥	10 % sand	"
C	① ② ③ ④ ⑤ ⑥	20 % "	"
D	① ② ③ ④ ⑤ ⑥	30 % "	"
E	① ② ③ ④ ⑤ ⑥	40 % "	"
F	① ② ③ ④ ⑤ ⑥	50 % "	"
G	① ② ③ ④ ⑤ ⑥	70 % "	"
H	① ② ③ ④ ⑤ ⑥	80 % "	"
I	① ② ③ ④ ⑤ ⑥	90 % "	"
J	① ② ③ ④ ⑤ ⑥	100 % "	"

From a study of the table it is seen that the average amount of dry matter yielded by the pairs that received nitrate of soda, is highest in every case except in the last group where pure sand alone was used; likewise these pairs made a greater gain over the check pairs than the pairs receiving dried blood in every case except the pure sand group. It is also worthy of mention that the mechanical condition of the soil seems not to have brought about any very great variation in the amount of nitrogen recovered under the different treatments until the 50 per cent. mark was passed. Up to this point the amount of nitrogen is sometimes slightly increased and sometimes decreased. It is of interest to compare the calculated amounts of nitrogen to be recovered from the shale in the various combinations with the net amount actually recovered.

There was recovered from the check cylinders in the pure shale group 1.043 gms. nitrogen. From the corresponding cylinders in the pure sand group there was recovered 0.198 gram nitrogen, obtained from the seed and any that may have been fixed by non-symbiotic bacteria. If now we subtract this from 1.043—the amount recovered from the check shale cylinders—we have .845 gram as the actual net recovery from these cylinders. Since the check cylinders of group B were 90 per cent. shale the theoretical recovery from these should be 90 per cent. of .845, which is .760 gram. But the actual amount of nitrogen recovered from the check cylinders of group B was 1.055 grams, and if we deduct from this the .198 gram recovered from seed, &c., we have .857 gram as the net recovery from the shale of group B. In a similar way the theoretical and actual net recovery from the humus of the shale may be obtained for each group, and when tabulated is as follows:

PER CENT. OF SHALE SOIL.	Theoretical amount of N. to be recovered.	Net amount of N. actually recovered.
100	.845	.845
90	.760	.857
80	.676	1.326
70	.591	.683
60	.507	.701
50	.422	.824
30	.253	.308
20	.169	.272
10	.084	.128
0	....	....

From this it will be seen that the net actual recovery of nitrogen from the humus of the shale soil where sand was introduced, was greater in every instance than the amount as calculated from the recovery of the shale soil alone. This indicates an improved condition of the soil due to the introduction of the sand. The amount of nitrogen recovered up to 50 per cent. of sand varies some, but is, on the average, between .8 and .9 of a gram. The highest recovery, as already pointed out, was with 20 per cent. of sand. With more than 50 per cent. of sand the decrease in recovery is rather rapid, and falls with 90 per cent. of sand to less than one-tenth the amount recovered with 20 per cent. of sand. The explanation for the increased nitrogen recovery with the introduction of sand would seem to be the better aeration of the soil, and the consequent more rapid ammonification of the organic matter present.

Mention may be made of the low percentage of nitrogen recovered from the blood with 20 per cent. of sand. This is no doubt due, in part, to the unusually high percentage of nitrogen—6.16 per cent.—in check cylinder C_2 which results in a high average for this check pair, and consequently a low percentage of recovery for the other two pairs. When we come to the group in which 70 per cent. of sand was used, we find that from this point on there is a gradual decline in the amount of nitrogen recovered. This is clearly shown in the following statement:

TREATMENT.	70 Per cent. sand. N. gms.	80 Per cent. sand. N. gms.	90 Per cent. sand. N. gms.	100 Per cent. sand N. gms.
Nothing	.506	.470	.326	.198
Nitrate of Soda	1.100	.800	.680	.334
Dried Blood	.854	.767	.636	.520

It is also to be noted that beginning with 70 per cent. of sand there is a distinct decline in the weight of dry matter produced. With no fertilizer and also with dried blood the highest amount of nitrogen recovered was with 20 per cent. of sand; where nitrate of soda was used, the highest amount was with the shale soil.

The superiority of dried blood over nitrate of soda in the pure sand is probably due to the more rapid loss of nitrate of soda through leaching, and further emphasizes the advantage of slowly available nitrogenous materials in an open sandy soil.

THE INFLUENCE OF NON-MAGNESIAN AND MAGNESIAN LIME ON THE YIELD OF DRY MATTER AND NITROGEN IN ALFALFA.

Experiment 8.

Forty-five pounds of red shale soil were placed in boxes, and to each box there was added 6 grams of acid phosphate, and 6 grams potassium sulphate. The boxes were inoculated with 0.1 per cent. alfalfa soil, and the moisture content brought to 15½ per cent. The total weight was 65 pounds.

The special treatment given and the yield of dry matter and nitrogen are shown in the following table:

SOIL SAMPLE NO.	Dry Matter. gms.	Nitrogen. %	Total N.	Average. gms.	Increase Over Check. gms.	Special Treatment.
	14	2.617	.3664			
1, 2.......	16	2.668	.4269	.3966	....	Nothing.
	19	2.761	.5246			
3, 4.......	19	2.845	.5406	.5326	.1360	5 gms. $CaCo_3$.
	15	2.952	.4428			
5, 6.......	20	2.915	.5830	.5129	.1163	10 " "
	18	2.902	.5224			
7, 8.......	16	2.912	.4659	.4941	.0975	20 " "
	20	3.032	.6064			
9, 10.......	16	3.019	.4830	.5447	.1481	50 " "
	19	2.945	.5596			
11, 12.......	21	2.751	.5777	.5686	.1720	100 " "
	24	2.795	.6708			
13, 14.......	17	2.798	.4757	.5732	.1766	2.5 gms. $CaCO_3$, 2.5 gms. $MgCO_3$.
	19	2.845	.5406			
15, 16.......	13	2.935	.3816	.4611	.0645	5.0 " " 5.0 " "
	17	2.878	.4893			
17, 18.......	18	2.996	.5393	.5143	.1177	10.0 " " 10.0 " "
	19	2.945	.5596			
19, 20.......	18	2.955	.5319	.5457	.1491	25.0 " " 25.0 " "
	18	2.915	.5247			
21, 22.......	19	3.049	.5793	.5520	.1554	50.0 " " 50.0 " "

The boxes receiving 2.5 grams of $CaCO_3$ and 2.5 grams of $MgCO_3$ yielded the most dry matter and nitrogen. These were closely followed by the boxes that received 100 grams of $CaCO_3$, and those that received 50 grams of each. The low yields obtained from boxes 7-8 and 15-16 can hardly be attributed to the lime treatment, since higher yields were obtained from boxes that received both lighter and heavier lime treatment. If we except boxes 14-15 where the yield seems to have been abnormally high, the best results were secured with the 50 and 100 gram portions of the $CaCO_3$ and with the 25 and 50 gram portions of the two carbonates, the $CaCO_3$ having a slight advantage. When we consider the total increase of nitrogen over the check plot, we find a slight advantage in favor of the $CaCO_3$, the figures being .6699 gram for the $CaCO_3$, and .6633 gram for the $CaCO_3$, $MgCO_3$. It appears, therefore, that the two carbonates used in equal portions for alfalfa gave practically the same results as an equal weight of the $CaCO_3$ alone.

In all cases the carbonates increased the yield both of dry matter and nitrogen.

MISCELLANEOUS VEGETATION EXPERIMENTS.

MODIFICATIONS INTRODUCED IN SOILS BY THE GROWTH OF LEGUMES.

Experiment 9a.

Following the corn crop of 1907, an account of which was given in the report for that year, the soils were removed from the cylinders (Group M, series 5-10), thoroughly mixed and 225 pounds returned to each cylinder. To each of the cylinders there was added 225 grams ground limestone, 30 grams acid phosphate and 15 grams of sulphate of potash, and on April 23d, 1908, 100 grains of oats were planted in each cylinder. The oat crop was designed to show whether or not the soil in the different cylinders was fairly uniform in composition.

In the following table is reported the weight of dry matter and nitrogen from the cylinders:

NO. OF CYLINDER.	Dry matter. gms.	Per cent. Nitrogen.	Total Nitrogen. gms.	Average. Nitrogen. gms.
5A	80	1.082	0.865	.....
B	77	1.105	0.850	.....
C	72	1.175	0.846	0.854
6A	70	1.172	0.820	.....
B	75	1.110	0.825	.....
C	75	1.195	0.896	0.847
7A	75	1.156	0.867	.....
B	80	1.089	0.871	.....
C	71	1.242	0.881	0.873
8A	72	1.179	0.848	.....
B	72	1.136	0.817	.....
C	79	1.133	0.895	0.853
9A	78	1.133	0.883	.....
B	79	1.179	0.931	.....
C	78	1.102	0.859	0.891
10A	73	1.156	0.843	.....
B	82	1.148	0.941	.....
C	83	1.172	0.972	0.919

There is a fair degree of uniformity in the weight of dry matter from the different cylinders; the percentage of nitrogen is also very uniform throughout the six series. The highest average yield of nitrogen was from Series 9 and 10. It is possible that this may be attributed to a heavy application of manure in connection with calcium carbonate, made in 1904. Series 8 had the same manure treatment but no calcium carbonate. In this connection it may be pointed out that Series 9 gave the highest yield of dry matter and nitrogen in the oat crop of 1904, with Series 10 only a little behind, while Series 10 gave the highest yield of dry matter and nitrogen in the corn crop of 1905, the highest weight of green rye in 1906 and 1907, and the highest weight of dry matter in the corn crop of 1907. There seems good reason to believe, therefore, that the oat crop of 1908 may have derived some benefit from the manure, in combination with calcium carbonate, that was applied in 1904.

Experiment 9b.

After harvesting the oats from the cylinders of group M in July, 1908, they received the following treatment:

Series 5, cowpeas grown and turned under for rye.
Series 6, equivalent amount of cowpeas from outside turned under for rye.
Series 7, crimson clover grown and turned under for corn.
Series 8, crimson clover from outside turned under for corn.
Series 9, winter vetch grown and turned under for corn.
Series 10, winter vetch from outside turned under for corn.

Cylinders 5a-10a were sprinkled with manure infusion before being turned under. 5b-10b were sprinkled with Azotobacter culture. 5c-10c were turned under without bacterial additions. The rye and corn yields, together with nitrogen recovered, are reported in the following table:

NO. OF CYLINDER.	Wt. dry matter. gms.	Per cent. Nitrogen.	Total N. gms.	Aver. N. gms.
5A	299	0.46	1.38	....
B	347	0.46	1.60	....
C	296	0.49	1.45	1.48
6A	297	0.49	1.46	....
B	259	0.54	1.41	....
C	287	0.46	1.32	1.40
7A	578	0.52	3.01	....
B	569	0.46	2.62	....
C	555	0.49	2.72	2.78
8A	401	0.48	1.92	....
B	416	0.43	1.79	....
C	453	0.45	2.04	1.92
9A	412	0.42	1.73	....
B	465	0.42	1.95	....
C	553	0.55	3.04	2.24
10A	444	0.40	1.78	....
B	499	0.37	1.85	....
C	491	0.47	2.31	1.98

It will be noted that the yield of nitrogen was larger, in each case, in the series where the crop was grown and turned under, than in those where an equivalent amount of the same material from another source was turned under. Series 7, on which crimson clover was grown and turned under, gave the highest yield, and series 9, where winter vetch was grown and turned under, the next highest. The dry matter from series 8 and 10 where crimson clover and vetch, from outside sources, were turned under, gave practically the same average yields of nitrogen. The results clearly indicate that there is an advantage in growing a legume crop on the land and turning this under, over turning under the same amount and kind of material brought from an outside source.

This points to an accumulation, in the soil, of nitrogen from the nodules of the legumes. The inoculated cylinders gave, on an average, a slightly lower yield of nitrogen than those that received no bacterial treatment as is shown by the following: 5a-10a, 1.88 grams; 5b-10b, 1.87 grams; 5c-10c, 2.15 grams. The highest yield was from 9 C on which was grown winter vetch without inoculation; the next highest 7 A on which was grown crimson clover, inoculated with Azotobacter.

THE PROTEIN CONTENT OF SOY BEANS AND BUCKWHEAT AS AFFECTED BY VARYING AMOUNTS OF LIME, GYPSUM AND ACID PHOSPHATE.

Experiment 10.

For this work boxes holding 45 pounds of a mixture of shale soil and sand, the sand forming 30 per cent. of the weight, were used. The moisture content was kept at 14-16 per cent. In one set of boxes soy beans were planted and in another set (treated in the same way) buckwheat was planted. The yield of dry matter and nitrogen recovered are reported in the following table:

SOY BEANS.

NO. OF POT.	Dry Matter. gms.	N. %	Total N. gms.	Total N. Average. gms.	TREATMENT.
	11	5.49	0.604		
53, 54......	11	5.32	0.585	0.594	No Lime, 6 gms. Acid Phos. 3 " K_2SO_4.
	17	5.97	1.015		
55, 56......	14	5.32	0.745	0.880	5.0 gms. Lime, 6 gms. Acid Phos. 3 " K_2SO_4.
	18	5.78	1.040		
57, 58......	16	5.77	0.923	0.981	10.0 " " 6 " Acid Phos. 3 " K_2SO_4.
	15	5.76	0.864		
59, 60......	15	5.61	0.842	0.853	20.0 " " 6 " Acid Phos. 3 " K_2SO_4.
	17	6.04	1.027		
61, 62......	16	6.00	0.960	0.993	2.5 " Gypsum, 6 " Acid. Phos. 10.0 " Lime, 3 " K_2SO_4.
	15	5.38	0.807		
63, 64......	12	5.20	0.624	0.715	5.0 " Gypsum, 6 " Acid Phos. 10.0 " Lime, 3 " K_2SO_4.
	17	5.94	1.009		
65, 66......	14	5.57	0.780	0.894	10.0 " Gypsum, 6 " Acid Phos. 10.0 " Lime, 3 " K_2SO_4.
	17	6.11	1.038		
67, 68......	18	6.17	1.111	1.074	1.0 gms. Acid Phos., 3 gms. K_2SO_4. 10.0 " Lime.
	16	5.85	0.936		
69, 70......	19	5.75	1.093	1.014	2.5 " Acid Phos., 3 " " 10.0 " Lime.
	15	5.76	0.864		
71, 72......	14	6.02	0.843	0.853	5.0 " Acid Phos., 3 " " 10.0 " Lime.

BUCKWHEAT.

NO. OF POT.	Dry Matter. gms.	N. %	Total N. gms.	Total N. Average. gms.	TREATMENT.
	42	1.34	0.56		
73, *74......	42	1.30	0.55	0.55	No Lime, 6 gms. Acid Phos. 3 " K_2SO_4.
	37	1.23	0.46		
75, 76......	41	1.20	0.49	0.47	5.0 gms. Lime, 6 gms. Acid Phos. 3 " K_2SO_4.
	44	1.26	0.55		
77, 78......	43	1.29	0.55	0.55	10.0 " " 6 " Acid Phos. 3 " K_2SO_4.
	38	1.34	0.51		
79, 80......	42	1.32	0.55	0.53	20.0 " " 6 " Acid Phos. 3 " K_2SO_4.
	44	1.31	0.58		
81, 82......	43	1.23	0.53	0.55	2.5 " Gypsum, 6 " Acid. Phos. 10.0 " Lime, 3 " K_2SO_4.
	49	1.19	0.58		
83, 84......	46	1.23	0.57	0.57	5.0 " Gypsum, 6 " Acid Phos. 10.0 " Lime, 3 " K_2SO_4.
	45	1.30	0.59		
85, 86......	35	1.15	0.40	0.49	10.0 " Gypsum. 6 " Acid Phos. 10.0 " Lime, 3 " K_2SO_4.
	38	1.19	0.45		
87, 88......	38	1.27	0.48	0.46	1.0 gms. Acid Phos., 3 gms. K_2SO_4. 10.0 " Lime.
	34	1.29	0.44		
89, 90......	34	1.17	0.40	0.42	2.5 " Acid Phos., 3 " " 10.0 " Lime.
	36	1.15	0.41		
91, 92......	32	1.16	0.37	0.39	5.0 " Acid Phos., 3 " " 10.0 " Lime.

* 73–92 had, in addition to the lime and minerals, 3 gms. of dried blood to each box.

The yield of nitrogen from soy beans with no lime was .594 gram; with lime there was an increase, on the average, of nearly .30 gram of nitrogen, though it is to be observed that the increase with 20 grams, equivalent to 4,000 pounds, per acre, was not quite equal to the increase with 5 grams or 1,000 pounds per acre. The gypsum appears to have had practically no influence, for the average from these pots was about the same as the average from the pots that received lime alone. In boxes 67-72 where 10 gms. of lime were used, and quantities of acid phosphate, from 1 to 5 gms. the average yield of nitrogen was slightly higher than where the same amount of lime and 6 grams of acid phosphate were used.

With the buckwheat series the lime and gypsum appear to have had practically no influence; the pots without lime gave a yield of .55 gram total nitrogen which was almost the maximum yield for the series. Pots 87-92 where 10 grams of lime were used with 1, 2.5 and 5 grams of acid phosphate show a slightly depressed yield. The following conclusions seem justified:

1. The nitrogen content of soy beans was distinctly increased by the use of lime, though lime at the rate of 4,000 pounds per acre did not appear to give any increase over the yield from 1,000 pounds per acre. The highest yield was obtained when the lime was used at the rate of 2,000 pounds per acre.

2. Gypsum appears to have had no influence on the nitrogen content of the beans.

3. Neither lime nor gypsum appear to have had any appreciable influence on the buckwheat.

4. Boxes receiving 1 gram and 2.5 grams of acid phosphate, and 10 grams of lime, yielded more nitrogen in the buckwheat than boxes that received 5 and 6 gms. of acid phosphate and 10 gms. of lime.

THE PROTEIN CONTENT OF SOY BEANS AS AFFECTED BY THE PROPORTION OF SAND IN THE SOIL.

Experiment 11.

The experiments were conducted in boxes of uniform size. To each soil portion was added 6 grams acid phosphate, 3 gms. potassium sulphate and 10 gms. prepared lime. The moisture content was brought to 14-16 per cent.

The following table shows the arrangement of the series and the yield of dry matter and nitrogen:

	Dry Matter. gms.	Per Cent. N.	Total N. mgs.	Total N. Average. mgs.	TREATMENT.
	16	5.43	0.869		
33, 34...........	14	5.13	0.718	0.793	Air dry shale soil, 45 lbs.
	16	4.99	0.798		
35, 36...........	17	5.28	0.898	0.848	" " " with 10% of sand.
	14	5.52	0.773		
37, 38...........	16	5.30	0.848	0.810	" " " " 20% " "
	16	5.75	0.920		
39, 40...........	16	5.55	0.888	0.904	" " " " 30% " "
	15	5.93	0.889		
41, 42...........	12	5.63	0.676	0.782	" " " " 40% " "
	13	5.85	0.761		
43, 44...........	12	5.81	0.697	0.729	" " " " 50% " "
	15	5.89	0.884		
45, 46...........	15	5.57	0.836	0.860	" " " " 60% " "
	15	5.97	0.896		
47, 48...........	15	5.95	0.893	0.894	" " " " 70% " "
	16	5.99	0.958		
49, 50...........	18	6.34	1.141	1.049	" " " " 80% " "
	18	6.21	1.117		
51, 52...........	11	5.89	0.648	0.882	" " " " 90% " "

The highest yield of dry matter and nitrogen was obtained from pots 49 and 50, where 80 per cent. of sand was used. This was closely followed, however, by pots 35 and 36, and 39 and 40 where 10 per cent. and 30 per cent., respectively, of sand was used. Closely approaching these in dry matter and exceeding one of them in nitrogen are pots 51 and 52 where 90 per cent. of sand was used. The lowest yield was obtained with 50 per cent. of sand. In all except two lots the mixtures of shale and sand produced a slightly higher yield than the shale alone.

While the differences are not great, yet the evidence points to a sandy soil as favoring a high protein content in soy beans.

THE INFLUENCE OF ORGANIC MATTER ON THE AVAILABILITY OF TRI-CALCIC PHOSPHATE.

Experiment 12.

In this experiment an effort was made to determine whether the organic acids resulting from the decomposition of the organic matter (dextrose) would act upon the insoluble phosphate and make it available. With this end in view large five gallon earthenware pots were used to hold the sand in which the crop was to be grown and each pot also held a one gallon porous pot filled with sand. In each case the phosphate and organic material were placed in the inner pot, which would allow any soluble material to pass through its walls. Together the pots held 55 pounds of sand which was inoculated with an infusion of fertile soil. Each outer jar received 3 grams of nitrate of soda, 30 grams of precipitated chalk, 6 grams of potassium sulphate, 1 gram magnesium sulphate and 0.5 gram ferric sulphate. The total weight was 91 pounds with a moisture content of 8-9 per cent. Barley was planted in the outer jars. The following table shows the treatment given and the yield of barley in grams:

NO. OF POT.	Dry Matter. gms.	Average. gms.	SPECIAL TREATMENT.
1, 2	31.0 31.5	31.2	Nothing.
3, 4	44.5 33.0	38.7	10 gms. acid phosphate.
5, 6	26.5 24.5	25.0	10 " Tri-calcic phosphate (Fla. hard rock No. 1).
7, 8	29.5 27.0	28.2	10 gms. Tri-calcic phosphate (Fla. hard rock). 10 gms. dextrose.
9, 10	21.5 23.0	22.2	10 gms. Tri-calcic phosphate (Fla. hard rock). 20 gms. dextrose.
11, 12	24.5 23.5	24.0	10 gms. Tri-calcic phosphate (Fla. hard rock). 50 gms. dextrose.

The weights from the different pots do not differ greatly, but there is good reason to believe that some of the acid phosphate did diffuse through the walls of the inner pots and increase the yield in these pots, which is more than was yielded by either the check pots or those receiving the insoluble phosphate. The average yields with the insoluble phosphate are less in each case than the yield from the check pots. In pots 9 and 10, and 11 and 12 where 20 and 50 grams, respectively, of dextrose were used, there is some indication that the dextrose diffused through the walls of the pots and depressed the yield of barley. (See Expts. Nos. 1 and 6 of this report.) Apparently the organic matter did not contribute towards making the phosphate available.

AVAILABILITY OF DIFFERENT FORMS OF PHOSPHORIC ACID.

Experiment 13.

In this experiment glass pots, painted outside, were used. In these was placed 20 pounds of white sand with 50 cc. of soil infusion. To each pot was added 10 gms. of precipitated chalk, 2 gms. potassium sulphate, 2 gms. nitrate of soda, 0.5 gm. magnesium sulphate, and 0.2 gm. ferric sulphate. The total weight was 33 pounds, with a moisture content of 12-13 per cent. Twenty grains of barley were planted in each pot.

The treatment given and the yield of barley are indicated in the following table:

NO. OF POT.	Yield of Dry Matter. gms.	Average. gms.	TREATMENT.
1, 2	3.5 5.0	4.2	Nothing.
3, 4	11.5 11.8	11.6	5 gms. acid phosphate.
5, 6	11.0 12.0	11.5	5 gms. Newberry's citrate soluble phosphate, No. 1 Fla. rock.
7, 8	10.0 12.0	11.0	5 gms. Newberry's citrate soluble phosphate, No. 2 Fla. rock.
9, 10	9.8 10.5	10.1	5 gms. Newberry's citrate soluble phosphate, No. 3 Fla. rock.
11, 12	12.2 12.8	12.5	5 gms. Thomas slag.
13, 14	12.5 13.8	13.1	5 gms. acid phosphate, and 5 gms. ground feldspar instead of K_2SO_4.

A comparison of the results obtained here indicates that there is little difference in the availability of the different forms of phosphate under consideration. The maximum yield was obtained with 5 grams of acid phosphate and 5 gms. of ground feldspar without the potassium sulphate; this is followed closely by the Thomas slag. The citrate soluble phosphate No. 1 gave practically the same yield as the acid phosphate alone. Numbers 2 and 3 show a slight falling off in yield.

THE AVAILABILITY OF GROUND PHOSPHATE ROCK AS COMPARED WITH ACID PHOSPHATE.

Experiment 14.

Twenty pounds of white sand were placed in painted earthenware pots and inoculated with 50 cc. of soil infusion, equivalent to 25 gms. soil. To each pot was added 10 grams precipitated chalk, 2 gms. potassium sulphate, 0.5 gm. magnesium sulphate and 0.2 gm. ferric sulphate. The pots were tared, at ten and a half pounds, and 11 per cent. moisture added, making a total weight of 33 pounds. Twenty grains of barley were planted in each pot. The phosphate used was Fla. hard rock analyzing 68 per cent. tri-calcium phosphate, 4 per cent. iron and alumina, and 3.0 per cent. moisture.

The treatment given and dry weight of barley obtained are given in the following table:

NO. OF POT.	FERTILIZER TREATMENT.	Yield of Dry Matter. gms.
1	Nothing	7.5
2	"	7.5
3	4 gms. acid phosphate	12.2
4	4 " " "	12.0
5	4 gms. ground rock, No. 1	15.5
6	8 " " " " 1	9.0
7	4 " " " " 2	12.5
8	8 " " " " 2	14.2
9	4 " Germofert	13.5
10	8 " "	12.0

From a study of the table it is seen that there is little difference in the yield of dry matter from the four sources of phosphoric acid. With ground rock No. 1 and Germofert, 4 grams gave a larger yield than eight grams. The yields given where the ground untreated rock was used compare very favorably with the yield from pots where acid phosphate was used, the average for the latter being 12.1 grams and for all the ground rock samples 12.8 grams.

Ground rock No. 2 was finer than No. 1.

THE INFLUENCE OF BORATES ON PLANT GROWTH.

Experiment 15a.

In the report of the Soil Chemist and Bacteriologist for the year 1909 there were published the results of some experiments planned to determine whether gypsum and calcium carbonate containing a small proportion of borates has an injurious effect upon the growth of plants. The conclusion reached at that time with reference to the gypsum was, that it may be employed in stables and barns when sanitary reasons make this desirable, without fear of producing undesirable effects in the soil, and with reference to the calcium carbonate, that it may be safely used in single applications of one to one and a half tons per acre.

However, there was appended to this conclusion a note in which it was stated that additional experiments made later, make it appear that the injurious effect of boric acid is greater than was at first indicated, and that it would be best not to use this lime at all. It therefore seems worth while to report here the data on which this later conclusion was drawn. The tests were carried out in earthenware pots holding 14 pounds of soil and 6 pounds of sand. To this mixture of sand and soil there was applied 4 gms. acid phosphate and 2 gms. potassium sulphate. One series of pots each was planted to barley, vetch and crimson clover, but since the clover seed did not germinate, this part of the report is omitted. The lime material is a by-product from the works of the Pacific Coast Borax Company, at Bayonne, N. J., and it was at the suggestion of Mr. George A. Bush that it was sold for agricultural uses. In the following table will be found the special treatment applied and the yields of barley and vetch:

BARLEY.

NO. OF POT.	Dry Matter. gms.	Average.	SPECIAL TREATMENT.
1, 2	19.0 18.5	18.7	Nothing.
3, 4	20.5 18.0	19.2	12 gms. oyster shell lime.
5, 6	17.0 16.5	16.7	30 " " " "
7, 8	9.0 9.0	9.0	12 " Bush's lime.
9, 10	5.5 5.5	5.5	30 " " "

VETCH.

11, 12	9.5 6.5	8.0	Nothing.
13, 14	4.0 7.7	5.8	12 gms. oyster shell lime.
15, 16	4.5 7.0	5.7	30 " " " "
17, 18	5.0 5.0	5.0	12 " Bush's lime.
19, 20	3.5 3.5	3.5	30 " " "

The injurious effect of the borated lime is at once apparent in the diminished yield of both the barley and vetch, and the yield was distinctly less with 30 grams than with 12 grams. The oyster shell lime, on the other hand, gave about the same yield with 30 grams as with 12, for both crops. It would appear, also, that this soil was not greatly in need of lime since the yields from pots receiving the oyster shell lime were not perceptibly greater than the yields from pots receiving nothing.

Experiment 15b.

A second experiment similar to the one just described was conducted to test Bush's lime after it had been subjected to the Ellis-Foster treatment (a secret process) to render the borax harmless.

In this experiment, as in the first one, earthenware pots holding 14 pounds of soil and 6 pounds of sand were used. To the mixture of soil and sand were added 4 gms. acid phosphate, 2 gms. potassium sulphate and 1 gm. nitrate of soda. The moisture content was brought to 12½ per cent. and barley planted three days after the treatment had been applied. The following table indicates the treatment given together with the yield of dry matter.

NO. OF POT.	Dry Matter. gms.	Average.	SPECIAL TREATMENT.
1, 2......	11.5 10.0	10.7	Nothing.
3, 4......	9.0 9.5	9.2	10 gms. oyster shell lime.
5, 6......	9.0 10.0	9.5	30 " " " "
7, 8......	10.5 9.0	9.7	10 " precipitated carbonate.
9, 10......	8.5 9.5	9.0	30 " " "
11, 12......	5.0 5.2	5.1	10 " " " + 2 % boric anhydride.
13, 14......	4.0 4.0	4.0	30 gms. precipitated carbonate + 2 % boric anhydride.
15, 16......	10.0 8.0	9.0	10 gms. calcium sulphate.
17, 18......	8.0 9.0	8.5	30 " " "
19, 20......	5.0 7.5	6.2	10 " " " + 2 % boric anhydride.
21, 22......	1.5 3.0	2.2	30 " " " + 2 % " "
23, 24......	11.5 12.5	12.0	10 " Ellis-Foster treated lime.
25, 26......	7.0 7.5	7.2	30 " " " "
27, 28......	6.5 6.0	6.2	5 " Bush's lime.

Here again the injurious effect of the boric acid is distinctly manifest. The yield drops from an average of over 9 gms. of dry matter where oyster shell lime and precipitated carbonate were used, to 5.1 grams where 2 per cent. of boric anhydride was used in connection with 10 grams of carbonate, and to 4.0 grams where 2 per cent. of boric anhydride was used with 30 grams of the carbonate. When 2 per cent. of boric anhydride was used with 10 and 30 grams of calcium sulphate the yield of dry matter was 6.2 grams and 2.2 grams, respectively. With the Ellis-Foster treated lime the yield was 12.0 grams and 7.2 grams of dry matter with 10 and 30 grams of the material, respectively. With the 10 gram portion the yield was slightly more than was obtained with oyster shell lime and precipitated carbonate, and also more than was obtained from the check pots. When the amount of material was increased to 30 grams there was a distinct depression in the yield. This decreased yield with the increased application still indicates an injurious effect with heavy applications, even after the material has undergone the special treatment. It is entirely possible, however, that with light applications, say 1,000 pounds per acre, the treated material would do no harm. In conclusion we may safely say that the farmer is taking some risk when he uses lime or gypsum compounds containing even small percentages of boric acid.

INOCULATION EXPERIMENTS WITH AZOTOBACTER BEYERINCKI.

Experiment 16.

This work was begun in 1904[1] when the soil was removed from the cylinders, thoroughly mixed, and an equal amount returned to each cylinder. The soil was a sandy loam, well aerated, and it seemed that here favorable conditions were offered for the fixation of atmospheric nitrogen by Azotobacter. These experiments having yielded negative results,[2] it was determined in 1908, to utilize in the experiment the well known favorable action of lime, and also the relation of the organisms to soluble and insoluble carbohydrates in the culture medium.

Each cylinder received 30 grams of acid phosphate and 15 grams of potassium sulphate.

Further treatment consisted of the following:

11a—18a..........no lime.
11b—18b..........125 gms. calcium carbonate.
11c—18c..........250 gms. calcium carbonate.

A number of the soils received, likewise, applications of organic materials that were to serve as a source of energy to Azotobacter. These applications were made as follows:

12a, 12b, 12c, 16a, 16b, 16c—30 gms. of cane sugar.
13a, 13b. 13c, 17a, 17b, 17c—30 gms. of starch.
14a, 14b, 14c, 18a, 18b, 18c—30 gms. of ground filter paper.

Soils 15a—15c, 16a—16c, 17a—17c, and 18a—18c were inoculated with cultures of A. Beyerincki. The corresponding soils 11a—11c, 12a—12c, 13a—13c, and 14a—14c were left uninoculated. Sixteen kernels of corn were planted in each soil on May 5th, and the entire crop was harvested on Sept. 1st. The yields of dry matter and of nitrogen are given in the following table:

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[1] Report Soil Chemist and Bacteriologist, 1907, p. 144.
[2] l. c. p. 169.

Pot No.	Dry Matter. gms.	Nitrogen. %	Nitrogen. gms.	Nitrogen Average Yield. gms.
11a	104	0.611	0.635	
b	147	0.482	0.708	
c	218	0.485	1.057	0.800
12a	90	0.422	0.379	
b	140	0.483	0.676	
c	177	0.445	0.787	0.614
13a	83	0.591	0.490	
b	178	0.637	1.133	
c	166	0.428	0.710	0.778
14a	93	0.540	0.502	
b	139	0.492	0.683	
c	176	0.475	0.836	0.674
15a	109	0.514	0.560	
b	138	0.471	0.649	
c	193	0.483	0.932	0.714
16a	81	0.595	0.481	
b	129	0.475	0.612	
c	141	0.466	0.657	0.583
17a	76	0.574	0.436	
b	107	0.526	0.562	
c	143	0.499	0.713	0.570
18a	84	0.547	0.459	
b	114	0.508	0.579	
c	146	0.491	0.716	0.585

The most striking fact which the examination of the above table reveals is that concerning the influence of lime on the yields of dry matter and of nitrogen. Remembering that no lime was applied in 11a—18a; 125 gms. in 11b—18b; and 250 gms. in 11c—18c we find the following relations:

Yields of Dry Matter and Nitrogen.

11a—18a		11b—18b		11c—18c	
Dry Matter. gms.	Nitrogen. gms.	Dry Matter. gms.	Nitrogen. gms.	Dry Matter. gms.	Nitrogen. gms.
90	0.493	136.5	0.700	170	0.801

It is evident that the large applications of calcium carbonate, at the rate of 2 tons per acre in 11b—18b; and at the rate of 4 tons per acre in 11c—18c, stimulated the growth of the decay bacteria and made possible thereby a larger supply of available nitrogen compounds to the crop. The increase of dry matter in 11b—18b, over 11a—18a is 46.5 gms., and the increase in 11c—18c is 33.5 gms. The corresponding increase of nitrogen was 0.207 gms. and 0.101 gms. respectively. Hence the additional applications beyond the first two tons still gave a very marked increase."[1]

From these results the following conclusions were drawn:

"1. Ground limstone hastened the decomposition of the inert humus compounds and made available a larger supply of nitrogen to the corn crop.

"2. Applications of ground limestone at the rate of 4 tons per acre proved even more effective than applications of 2 tons per acre in hastening the decomposition of the inert humus compounds.

"3. Applications of sugar, starch and ground filter paper depressed the yields of dry matter and of nitrogen in the corn crop.

"4. Inoculation with A. Beyerincki in the presence or absence of organic substances depressed, rather than increased the yields of dry matter and of nitrogen in the corn crop."

Following this work a residual crop of corn was grown in these cylinders in 1909. No special treatment was applied but to each cylinder was added 20 grams of acid phosphate, and 10 grams of potassium sulphate. In the following table will be found the yield of corn for 1909 and also a statement of the lime treatment which was given in 1908:

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[1] l. c. pp. 144–145.

CYLINDER No.	Weight Dry Matter. gms.	Per Cent. Nitrogen.	Total N. gms.	Average. N. gms.	Lime Treatment, 1908.
11A	91	0.60	0.55		No lime.
B	119	0.59	0.70		125 gms. lime.
C	124	0.63	0.78	0.68	250 " "
12A	91	0.62	0.56		No lime.
B	122	0.61	0.74		125 gms. lime.
C	136	0.59	0.80	0.70	250 " "
13A	96	0.63	0.60		No lime.
B	129	0.58	0.75		125 gms. lime.
C	123	0.58	0.71	0.69	250 " "
14A	97	0.59	0.57		No lime.
B	124	0.58	0.72		125 gms. lime.
C	122	0.59	0.72	0.67	250 " "
15A	92	0.58	0.53		No lime.
B	100	0.61	0.61		125 gms. lime.
C	113	0.59	0.67	0.60	250 " "
16A	90	0.61	0.55		No lime.
B	117	0.56	0.66		125 gms. lime.
C	110	0.59	0.65	0.62	250 " "
17A	88	0.56	0.49		No lime.
B	121	0.55	0.67		125 gms. lime.
C	124	0.52	0.64	0.60	250 " "
18A	90	0.54	0.49		No lime.
B	117	0.53	0.62		125 gms. lime.
C	111	0.54	0.60	0.57	250 " "

Here as in 1908 the yield of dry matter and nitrogen are greater in every instance where lime was used than where no lime was used. However, the yield from the cylinders receiving 250 grams is not, on an average, appreciably higher than the yield from those receiving 125 grams. The average yield of nitrogen does not differ greatly from the average yield of 1908. The evidence is conclusive that this crop was benefited by the lime that was applied the year before.

As to the influence of the carbohydrates the evidence is less striking. Certainly there was not a pronounced depressing effect, as there was in 1908, and in two of the series the effect may have been slightly stimulating.

REPORT OF THE BIOLOGIST.

REPORT OF THE BIOLOGIST.

OBSERVATIONS OF NATURAL PROPAGATION OF OYSTERS AT BARNEGAT, N. J., IN 1911.

Meteorological conditions for the first half of the year 1911, have been unusual and record-breaking. On the whole, however, these conditions were favorable to oyster propagation. In a general way an excellent "set" of oyster seed has been reported from various points of the northern oyster field.

Unfortunately for the opportunity to make cultch experiments, the Barnegat region was an exception, there being no appreciable "catch" at all. This is the more remarkable as our observations show that a more abundant lot of spawn and developing fry were present in the water, than we had ever seen in previous years.

Peculiarities of the Season.

From the meteorological summary issued by the weather bureau, we select those data that have influence on oyster propagation during the past season, and condensing, we note the following peculiarities:

September and October, 1910, were unusually dry and mild, while November was unusually cold and wet. December proved to be the coldest known in thirty years, and the precipitation was below the normal. January, 1911, was remarkably warm, with normal precipitation. February was typical as to temperature, but deficient in moisture, and in amount of sunshine. March, 1911, was just opposite in character to that of the same month a year before. It was very wintry, and until near the close, also dry, when the normal precipitation was attained. April was cold, but normal in rainfall and in the amount of sunshine. May was a record-breaker, giving us midsummer temperatures with great drought. There was, however, enough water stored in the soil to keep the streams from running seriously low. But the month of June continued the dry spell, except for a short time near the middle. The first half of this month was cold, but the second half was characterized by the usual warm waves.

Now began an extremely hot spell that lasted through the first half of July, with continuation of dry weather; the severe storms of the second part of the month failed to relieve the lack of water in the streams, because of the great dryness of the soil. The temperature for the second half was below normal. August in a general way repeated the story of July, but ended with record-breaking rainstorms that produced great and damaging freshets. Up to that date, the salinity of the water in the estuaries had been high, and kept at a steady level; the freshets so reduced this salinity and for such a long period, as to kill or greatly injure oysters and spat in the rivers.

The season was favorable to the production of an abundance of spawn in the oysters, and a corresponding abundance of developing fry. The latter generally reached the spat stage—except at Barnegat. In the latter part of this report we discuss the question as to the cause of this exception.

Influence of Climate on Oyster Propagation.

A general analysis of the weather conditions in relation to oyster propagation, shows how naturally the facts observed in connection with such propagation correlate with the peculiarities of the weather. The great heat of May, following two months of cold weather, in the spring, caused a great hastening of all living developmental processes. The temperature of the water, on the shallow areas over oyster beds, was rapidly increased, so that oysters in these situations rapidly matured their spawn. Some of these oysters spawned in the latter part of May, and the fry had become half-grown by June 11th. The tendency to eject spawn was checked by the cold weather that followed, so that when warm weather returned, it was not until July was ushered in with its record-breaking hot wave, that the oysters were ready to throw out their spawn. The heat was so intense, that the spawning was correspondingly extensive. The number of fry found in the water on the fifth and sixth of July exceeded by over fifty per cent. the highest count we had ever made in the best previous years.

It seems probable that the oysters which spawned early, were stimulated by the protracted warm wave, to produce a second crop of spawn. This was also true of oysters spawning later, but the cold weather of the latter part of July checked the development of this spawn until the warm spell in August arrived. The story was then again repeated, and had not the latter month ended with the great freshet there would have been a chance for a September set.

Oyster Observation Service Established.

The remarkable abundance of fry in the Barnegat waters, associated with a still more remarkable failure of the spatting, can be explained only by carefully comparing climatic influences at different localities where spatting fails, with similar factors at places where spatting is abundant.

Accordingly, it was most opportune, that through the efforts of the Bureau of Shell Fisheries, the Legislature passed a law authorizing the bureau, in co-operation with the biologist of the Agricultural College Experiment Station, to establish an observation service at various points of our oyster producing areas. Unfortunately, no provision was made for meeting the expenses of such a valuable and necessary undertaking.

Anticipating a remedying of this in the near future, we made preparation for such work by issuing a set of blanks on which the results of the observations to be made can be properly recorded. On the back of each blank are printed the directions for making the observations and recording the data, together with a list of the apparatus needed. This apparatus was selected, and when the proper instruments were not to be had in the market, the specifications for the making of the same were supplied.

Description of the Blanks.

"Form A" provides for a record of the air conditions that have an influence on the growth and propagation of oysters. The temperature is recorded at 6 A. M., 10 A. M., 3 P. M. and 9 P. M. The direction and force of the wind are noted, the amount of sunshine, and of rain and miscellaneous data or explanations, are provided for.

"Form B" provides for recording the water conditions, such as the time of occurrence of high tide, its height, character, temperature and density, with similar data in connection with low water; and in special cases comparison is made between the water at the surface and at the bottom, at selected localities.

"Form C" provides for recording the condition of the oysters that are to furnish the spawn. This is effected by opening them and examining as to the maturity of the spawn, noting the sex, and the proportionate number of the sexes. Provision is also made for recording the results of the development of the eggs by fertilization tests, to see that the eggs are properly mature so they can develop. The kind of oysters used, and their history is also recorded.

"Form D" provides for recording the results of filtering samples of sea water to ascertain the presence of developing oyster fry, or larvæ. Here is noted the locality, the stage and phase of the tide at the time the water was taken, the amount of water filtered, the total number of fry, the relative proportion of newly hatched, half grown and of fully grown larvæ, and finally note is made of the presence of other larvæ, the amount and character of the sediment and of oyster food in the water.

"Form E" provides for entering observations on the set of spat, both on natural and on planted cultch, as well as on experimental cultch. The date when the cultch was planted, and the date when it was examined, the locality, the position of the shells, the number, size and distribution of the spat, on the upper and on the lower surfaces, respectively, together with a notice of the growth and condition of the adult oysters, all these data are to be entered in appropriate columns.

Number of Stations Needed.

The stations for observing these data should be located as near the most important natural beds and largest planting areas as possible. While there are many points along our coast where such stations could be advantageously located, it is not to be expected that provision will be made for establishing and maintaining a considerable number of stations. But if only a limited number are placed in the most important localities and a record is kept for a number of years, the stations can advantageously be moved to new locations, until in time a very thorough knowledge will be gained of the local and general conditions, and their relative effects on the growth and propagation of oysters.

Kind of Observers Needed.

It is evident that to properly fill out some of the blanks, particularly the ones calling for fertilization tests, and for filtration studies, the services of experts will be needed, that is, persons who have learned to use the microscope in biological work, such as those pursuing a biological course in colleges. But observations of this advanced character are confined to the two or three summer months. As for the rest of the year, it will be sufficient to keep record of the tidal changes, temperature and salinity, and of the condition of the oysters in respect to appearance and quality as is ascertained by those who are in the work of marketing them. These various observations would not have to be made oftener than twice a week in the autumn and spring, while during the winter a less frequent record would suffice. It will therefore be most feasible to employ experts for the summer and to rely on the services of some person connected with the oyster industry, for the balance of the year.

Directions for Observing and Recording the Data.

In connection with these directions we mention and, whenever necessary, describe the instruments used as they are mentioned. First of all, it will be necessary for the observer to live close to the field of his operations. If there is no oyster shanty or "shack" available, it will be necessary to erect a house. This need not exceed in cost a hundred dollars, nor in size 8 by 12 feet. The frame consists of 2 by 4 studding resting on a foundation of six piles. The enclosure is of tongue and groove boards running up and down; the roof is shingled. Each side is pierced by an aperture, giving three windows and a door.

Preferably a ceiling should be put in, as a floor for an attic under the roof. If this is used as sleeping quarters, half sash windows should occupy each gable. It will be necessary to have the windows slide inside between horizontal studs, and to have efficient mosquito nets on the outside. The door should be in the south wall, and open inward, with a screen door outside. Provision should be made for a shelf or table, twenty-seven inches high, to be used as the microscopical or laboratory bench. This should be placed under the north window, which should be lower than the other windows, and not far above the work bench. The furniture should consist of a cupboard, dining table, chairs, oil stove and cans, lamp and lantern, dishes and cooking utensils. There should be a cot and a bunk, each with a mattress, blankets and other bedding. This equipment might be kept in cost, close to fifty dollars.

Next will be needed a rowboat, or a small sneakbox, and oars. A half dozen galvanized pails or buckets will be needed for collecting samples of water. It will be useful to have a maximum and minimum thermometer, though we have provided only a *bath thermometer* to be used not only for taking the temperature of the water, but of the air as well. The readings of this instrument early in the morning and in the middle of the afternoon will be near enough to the minimum and maximum temperatures, for practical purposes. The direction of the wind can be readily ascertained by the position of the house, though a vane is readily made. A commercial *rain gauge* is not essential; by catching the rainfall in an ordinary pail, the area of whose top opening has been calculated, and measuring the volume of water caught, the rainfall can be easily calculated. The *specific gravity* of the water is ascertained by means of the salinometer, which is furnished specially with our sets of instruments; the scale of the ordinary hydrometer is too extended to be easily read. The salinometer scale runs only from 1,000 to 1,030. At each observation of density, the temperature of the water should be simultaneously recorded, so that the true specific gravity can be calculated by any one who wishes to work up the data. Some thermometers are provided with a centigrade scale; as our readings are according to the Fahrenheit scale, we annex a table of equivalents to aid in the rapid conversion of one scale into the other. For getting the surface water, a dipper is useful. While the buckets may be used for floating the salinometer, it is more convenient to use a cylinder made for this purpose out of metal.

For getting samples of the *bottom water*, we have used a bilge pump to which was screwed a length of hose. But for deep water, it is better to use a large bottle to which strong cord is attached. In the bottle is placed enough shot to sink it, held on place with paraffin. The bottle is fitted with a stopper to which the string is also attached, so that when the string is lifted the bottle hangs suspended by the cork. The latter must fit so that a slight jerk will draw the cork. The corked bottle is thrown overboard and allowed to sink to a desired depth, and then the cork is jerked out, and when the bubbles of air that leave the bottle have ceased to come to the surface, the bottle is hauled up. The bottle should have a capacity of about a quart, so that a sufficiently large sample may be secured for filtration.

The *height of the tide* is ascertained from a gauge, made by driving a pole or board into the bottom, in a sheltered place. This pole is marked with divisions at intervals corresponding with the average fall of tide per hour. The height in feet and inches is indicated at the divisions. The zero of the scale should correspond with the lowest water. To secure the maximum and minimum records automatically, it will be necessary to slip a float having a suitable hole in the center, over the gauge, and fit a pawl above and below, so that when low water is reached the upper pawl catches, and holds the block until released. The other pawl should catch at the high tide. Unfortunately there will be no automatic record of the time when high or low water occurred. While this point is important, it will serve all practical purposes to calculate the time as closely as possible, to the limit of error, of say half an hour. To observe *spawn conditions*. it will be necessary to open not more than a dozen oysters. They may be secured by means of tongs or rake, which can usually be borrowed from oystermen; or oysters can be secured from those that oystermen are actually engaged in catching. For opening the oysters, an oyster knife is not absolutely essential. Enough of the nib can be broken off with a hammer or a pair of nippers to permit the insertion of a thin knife blade to cut the muscle. It is easy to see how much spawn is present. If the oyster has begun spawning, it will be seen that as the mass of spawn has moved backward toward the vent, the dark liver near the hinge end begins to shine through the flesh.

Fertilization Test.

To ascertain the sex, the point of a knife is thrust into the reproductive "milk" and enough will stick that can be smeared onto a glass slide for examination with the compound microscope. It is at once seen whether sperms or eggs are present, and whether the sperms are motile or not, and if the eggs are clean, or are imbedded in a mass of granular material, or are decomposing. There is always some spawn left in the body of an oyster, which decomposes and is reabsorbed, and sometimes the entire lot of spawn is thus retained and absorbed without ejection. In order to test the character of the eggs, it will be necessary to make a *fertilization experiment.* For this purpose the oysters must have been freshly taken from their beds, and opened with great speed. While making the examination for determining the sex, as fast as suitable spawn is discovered, it should be picked out of the oyster on the point of the knife, and washed off into a dish containing sea water as nearly as possible like that to which the oysters used have been accustomed. An excellent way to proceed is the following: Take two clean tumblers, label one "m," the other "f." Fill each half full of the proper water. From each male oyster with motile sperms, wash one knife point full of its spawn into "m." From each female with suitable eggs take as much spawn as desired and place it into "f." The time occupied by this procedure should not exceed ten minutes for the entire operation; I came near saying that not more than ten minutes should elapse from the time the oysters leave the water until the eggs are fertilized. The greater the expedition the better the result. The next step is to pour a small part of the water of "m" into "f," and to throw away the balance of "m." Into the empty tumbler "m" is now poured the contents of "f," and back and forth a few times between the two tumblers to secure aeration and good mixture. Each time wait a few moments to allow debris to settle, which should be discarded. Then the mixture is evenly divided between the two tumblers, each of which then should not be more than a third full. After standing for five minutes, to allow the eggs to settle, the milky water above them is poured off so far as is possible, without losing the eggs that settled to the bottom, and then new water is added, to the depth of an inch, and the tumblers are set aside for another five minutes, when the operation is repeated. When no further milkiness appears in the water after the eggs have settled, the tumblers may be half filled with water, and be only occasionally treated to a renewal of the water; but the eggs should by stirring or other methods, be prevented from lying on the bottom longer than ten or fifteen minutes at a time. In from three to six hours, according to the temperature, the eggs hatch, and the larvæ begin swimming up into the supernatant water. After an hour or so the sediment left on the bottom, consisting of weak embryos and undeveloped eggs, is discarded, and more water is added to the fry until the tumblers are half full. The larvæ should be aerated occasionally by the pipette, or by the process of "cocktailing" between the tumblers. In less than one day after hatching the larvæ should have acquired bivalved shells, with equal valves, shaped like the shell of a scallop; after which they do not swim so actively, but are more readily picked up from the bottom with a dropper and transferred to a watch glass for examination with the miscroscope.

Because beautiful larvæ which will fail to develop shells, can be secured when immature eggs are fertilized, or when mature eggs are improperly handled, it is necessary to be careful (1) that the oysters were opened and examined at once on removal from their native water, (2) that there is no overcrowding, nor leaving the sperm water on the eggs more than ten minutes, which is the time it requires for the egg to be impregnated. In case *no shell* appears within thirty hours after fertilization, at summer temperature, if the proper treatment has been given, then the experimenter is justified in concluding that the eggs are not of the right character for making fry under natural conditions, either, because not yet mature, or for other reasons at present impossible to state.

Collecting Natural Fry.

To filter sea water to secure the fry produced in it by natural fertilization, it is needful to have a large rapid filtering funnel, and a supply of strong rapid filter paper. Lautenschläger's paper for filtration of agar, is the only kind we have found to work properly. These filters are folded into quadrants, and are smoothly fitted into the funnel, with three layers on one side and one on the other. The water should have been taken when there is the least amount of sediment suspended in it, as the presence of much sediment will obscure the larvæ when search for them is made with the miscroscope; furthermore, this sediment clogs the filter so that one despairs of getting the water filtered in a reasonable time, to say nothing of its interference, etc., in the subsequent manipulations. Therefore in shallow water we must secure samples when there is least wind; and in strong tidal currents, we must wait for the close of slack water. If there are more than thirty larvæ present per bucketful it will not be advisable to filter more than a fifth of the supply, first having stirred the sample to distribute the fry evenly. In this case the number found should be reduced to standard by multiplying by five.

The water that is to be filtered, having all been transferred into the funnel, the next step is to watch until only a small amount remains in the filter. Then a tumbler is placed below the funnel, and the tip of the filter is punched through with a pipette syringe so as to dump the residue into the glass. Next, the sediment that has gathered on the sides of the filter is washed down into the glass with the syringe; and the inside fold of the filter is opened, and the sediment that has crept in under this fold is also washed off. The tumbler should then be about half full of the dirty water, containing a concentration, not only of the sediment, oyster food, sand, etc., but also of the oyster fry, and other larvæ. We must now add a few drops of formalin solution to kill the fry, so they will drop to the bottom. The glass is set aside for about a quarter of an hour or longer, and then the supernatant water is poured off, until the amount that remains will not exceed the capacity of the sedimentation glass. A conical wineglass is excellent for this purpose; and as soon as the residue has been transferred, it is stirred with the dropper pipette, and the heavy debris that settles into the point of the glass within the first five seconds, is drawn off with the dropper and discarded. Then the sediment is again stirred and that which collects in ten or fifteen seconds is taken and put into a Syracuse watch glass.

The original form of solid watch glass having a deep hollow is now no longer manufactured; but as it is the only thing that can be used in this work, the observers will have to depend on the limited supply now on hand. Only a single or at most two dropperfuls are to be placed in the watch glass. This is then shaken with a circular movement, but without rotating the glass, until the sediment has collected in the center. Then the lighter sediment on top is sucked away, and the glass is shaken laterally to get the sediment into a windrow. This row is next searched under the compound microscope from end to end consecutively, using a teasing needle to uncover the fry when necessary. The fry are meantime counted and an estimate (at least) made of the proportion that are small or newly spawned, and of those that are full grown or ready to set. The smallest have shells like those fertilized artificially; none younger than the shell stage have been found in the water taken from natural oyster beds. The mature larvæ have the umbo of the left valve projecting decidedly beyond the right one. The medium sized larvæ look so near like clams that the only difference we have been able readily to detect is that the clam fry are larger; but as both sorts of fry are growing rapidly, it is evident that young clam fry must frequently be counted as older oyster fry, so far as the medium stages are concerned. The numbers found are recorded on a slip of paper, and then a new sample of debris from the sedimentation glass is examined in a similar manner, until no more larvæ show up. The largest ones fall first, and the smallest last, with, of course, some intermixture, because of the varying depth through which they have to fall. The figures on the paper are summed and reduced to standard and entered for that bucket, on the record blank, as coming from a particular locality at a particular stage of the tide.

Spatting Observations.

In recording the observed results in reference to spatting, we may examine the cultch placed by the oyster planters. But it is also necessary to make two sorts of experimental plantings of cultch. (1) Select clean shells and mark each one so it can be identified as having received a particular treatment during a definite interval. These are placed in various positions and situations and depths. They may be examined within three days, and before they have become fouled by growths and deposits. The shells should be allowed to dry, and then by using a hand lens magnifying about ten diameters, the very young spat can be seen, and it will even be possible to determine the date when each became attached, almost to the hour, by comparison with the figures given on Plates II. and III. of the report of the biologist for 1907. (2) Plant bucketfuls of shells in heaps, at various dates and at various places, to be examined after a week or longer, when the spat can be readily seen with the naked eye. Very valuable information can thus be secured in regard to the spatting periods, their date and duration. By keeping these shells in the same position when they are examined, as they occupied in the heap, it will be possible to determine the preferences of the fry in choosing their stool, and something can be learned as to the best sort of surface and of cultch. In the case of the marked shells, they are placed only at the date when the filtration observations show that there are fry ready to set; they are used for the immediate purposes of the observer, to guide the work and for studying more delicate questions than can be solved by the shell heap method.

The Cost of Such Service.

From the foregoing it is plain that the expert observer will need special preparation for this work, taking lessons under the supervision of the biologist for a week or two in the latter part of June.

In regard to the cost of the service, apart from the compensation that should come to the director of the service, the laboratory apparatus, including the compound microscope with its accessories, has been put up into sets by the A. H. Thomas Company of Philadelphia at the very low figures of thirty-five dollars for the set. The laboratory building and its equipment will add sufficient to bring the cost of *establishing* a station to about two hundred dollars. As to the cost of *maintenance,* the board will cost thirty dollars per month, so that a hundred dollars will suffice for this item for the season, provided the observer is his own cook. It is, of course, very useful at times to have present a second person. In many cases the oystermen render assistance, but of course only sporadically. If an assistant is hired who could do most of the cooking, the expense will be doubled for board, and as much more for his salary so that this item would then come to three hundred dollars for the season. Then the salary of the expert at say fifty dollars per month, will run up the summer cost to four hundred and fifty if the service is to run for three months. It may be possible to secure the observations for the balance of the year which will take about sixty hours of time, for fifty dollars. Maintenance, therefore, will cost from three hundred to five hundred dollars per year for each station, according to the extent of the service demanded. For purposes of calculation, the average of four hundred dollars will be fair.

It will be necessary to decide on the number of stations. Assuming that three stations are added the first year to the ones now attended to by the biologist, we should need an appropriation of about two thousand dollars. If this is continuous, it will permit of establishing one new station each subsequent year until the stations shall be five or six in number, which will be a very satisfactory showing. We have purposely left out of our calculations any estimate of the compensation due the director. The biologist at present receives nothing as salary from the State, as he does the work as biologist of the experiment station. To assume the directorship of this additional work will greatly add to his duties.

TABLE OF FAHRENHEIT AND CENTIGRADE APPROXIMATE EQUIVALENTS.

Fah.—Cen.	Fah.—Cen.	Fah.—Cen.	Fah.—Cen.
32.0— 0.0	51.0—10.5	70.0—21.0	88.7—31.5
33.0— 0.5	52.0—11.0	70.7—21.5	89.0—31.7
34.0— 1.0	52.7—11.5	71.0—21.7	89.5—32.0
34.7— 1.5	53.0—11.7	71.5—22.0	90.0—32.2
35.0— 1.7	53.5—12.0	72.0—22.2	90.5—32.5
35.5— 2.0	54.0—12.2	72.5—22.5	91.0—32.8
36.0— 2.2	54.5—12.5	73.0—22.8	91.5—33.0
36.5— 2.5	55.0—12.8	73.5—23.0	92.0—33.3
37.0— 2.8	55.5—13.0	74.0—23.3	92.3—33.5
37.5— 3.0	56.0—13.3	74.3—23.5	93.0—34.0
38.0— 3.3	56.3—13.5	75.0—24.0	94.0—34.5
38.3— 3.5	57.0—14.0	76.0—24.5	95.0—35.0
39.0— 4.0	58.0—14.5	77.0—25.0	96.0—35.5
40.0— 4.5	59.0—15.0	78.0—25.5	97.0—36.0
41.0— 5.0	60.0—15.5	79.0—26.0	97.7—36.5
42.0— 5.5	61.0—16.0	79.7—26.5	98.0—36.7
43.0— 6.0	61.7—16.5	80.0—26.7	98.5—37.0
43.7— 6.5	62.0—16.7	80.5—27.0	99.0—37.2
44.0— 6.7	62.5—17.0	81.0—27.2	99.5—37.5
44.5— 7.0	63.0—17.2	81.5—27.5	100.0—37.8
45.0— 7.2	63.5—17.5	82.0—27.8	100.5—38.0
45.5— 7.5	64.0—17.8	82.5—28.0	101.0—38.3
46.0— 7.8	64.5—18.0	83.0—28.3	101.3—38.5
46.5— 8.0	65.0—18.3	83.3—28.5	102.0—39.0
47.0— 8.3	65.3—18.5	84.0—29.0	103.0—39.5
47.3— 8.5	66.0—19.0	85.0—29.5	104.0—40.0
48.0— 9.0	67.0—19.5	86.0—30.0	
49.0— 9.5	68.0—20.0	87.0—30.5	
50.0—10.0	69.0—20.5	88.0—31.0	

ABBREVIATIONS USED IN THE TABLES

Anch.—At head of boat anchorage in the Outlet.
B. B.—Barnegat Bay.
Br.—Near the boat "Bernice."
Brg.—Bridge across Barnegat Creek.
B't. Cl.—Barnegat Club House.
C.—Cox's Cove near the "Cynthia."
cl.—Clam fry.
Cl. F.—Near the Clam Floats, in the outlet channel.
E.—East.
E. B. C.—East of Big Cat Island.
E. C. I.—East of Little Cat Island.
E. Sl.—East of the "Nautilus."
F.—Further along on the previous course.
Fah.—Temperature of the air in the laboratory.
F. R.—Off the mouth of Forked River.
F. R. L.—Up Forked River at farthest oyster lots.
H.—Height of high water.
H. P.—Horace Point, opposite City Dock.
H. St.—At Hollingsworth's line of stakes.
L.—Height of low water.
lg.—Large size of fry.
Med. (or m.)—Medium sized fry.
Mid.—Midway between surface and bottom of water.
Bot.—Water taken at bottom.
Min.—Minus, e. g., below zero of tide gauge.
N.—North.
N. Ot.—Northern side of outlet channel.
O. Lt.—Oyster lots in Bay, north of "Nautilus."
O. Sl.—Between Outlet and anchorage of sloop "Nautilus."
O't.—Outlet of creek into Bay, beyond City Dock.
Ph. Cl.—Opposite the Philadelphia Club House.
R.—At Ramcat Point.
S.—South.
s. (or sm.)—Small size of oyster fry.
Sh.—Shad Point.
Sl.—Near the sloop "Nautilus."
S. O't.—Southern side of outlet.
S. S.—Opposite the Sans Souci,
S. St.—Southernmost stake.
Temp.—Temperature in degrees Fahrenheit.
W.—West.
W. B. C.—West of Big Cat Island.
W. Ck.—West side of Barnegat Creek at lagoon.
W. L. C.—West of Little Cat Island.
Wt.—Off Waretown.

ADDITIONAL ABBREVIATIONS ON THE CHART.

a.—Moon in apogee.
F.—Full moon.
Fah.—Fahrenheit thermometer scale.
h.—Moon highest in heavens.
l.—Moon lowest in heavens.
Max.—Maximum, or highest.
N.—New moon.
Nat.—Natural oysters or "Natives."
p.—Moon in perigee.
1st Q.—First quarter of moon.
3d Q.—Third quarter of moon.
r.—Rain.

TABLE I.—WEATHER FACTORS INFLUENCING OYSTER PROPAGATION AT BARNEGAT, SEASON OF 1911.

DATE	Hour.	Fah.	Sky.	Wind.	Force.	Tide.	Phase.	Remarks.
June 11	11:30 a. m.	82°	Muggy	S. W.	Weak	7	Ebb	Thunder storm, morning.
" 12	8:00 a. m.		Showers			10	Flood	Wind storm, night.
" 12	10:00 a. m.	74°				11	Ebb	Small oysters are most advanced.
" 12	2:30 p. m.	80°	Muggy	E.	Weak	8	Ebb.	
" 12	7:00 p. m.		Threat.	S.	Mod.	11	Flood	Thunder storm, evening.
" 13	8:30 a. m.	70°	Showers	S.		11	Flood	Wind E. at 9:00.
" 13	11:30 a. m.		Rain	W.		11.5	Ebb	Wind W., 10 a. m., rain.
" 13	3:00 p. m.	76°	Clear'g	W.		9.5	Ebb	Wind turns S., warm.
" 13	6:00 p. m.	72°	Clear'g	S. E.		9.5	Flood.	
" 14	7:00 a. m.	68°	Clear'g	N. W.	Mod.	10	Flood	Bay plants as forward as naturals.
" 14	11:30 a. m.	74°	Clear'g	N. W.	Incr.	13	Flood.	
" 14	2:45 p. m.	75°	Cloudy	N. W.		10	Ebb.	
" 14	6:00 p. m.	75°	Rain	N. W.		7.5	Low.	
" 15	7:00 a. m.	66°	Clear	N. W.	Strong.	9	Flood.	
" 15	9:00 a. m.	76°	Clear	N. W.		10	Flood.	
" 15	2:00 p. m.	80°	Clear	N. W.		11	Ebb	Tide 9.5 at 3:00.
" 16	6:15 a. m.	63°	Clear	N. W.	Weak.	9	Ebb.	
" 16	9:30 a. m.	73°	Clear	N. W.	Mod.	8.5	Flood	Wind storm at 11:00.
" 16	3:15 p. m.	81°.	Clear	N. W.	Strong.	8	Ebb.	
" 16	6:00 p. m.	72°	Threat.	N. E.	Strong.	10		
" 17	6:00 a. m.	57°		N. W.	Weak.	8	Ebb.	
" 17	8:00 a. m.					6.5	Ebb.	
" 17	9:00 a. m.	68°		N. E.	Calm.		Low	Large oysters have begun spawning.
" 17	11:00 a. m.	73°		S. E.		7.5	Flood	Commencement break.
" 22	8:00 p. m.	78°		E.	Weak.	10	Ebb.	
" 23	9:00 a. m.	76°	Clear'g	N.	Weak.	7	Ebb	Rained during night.
" 23	11:00 a. m.	70°	Hazy		Calm.	5.5	Ebb	Bay plants transferred to cove, June 17th, absorb their spawn.
" 23	12:00 noon.	85°		N. W.	Mod.	5	Ebb	

TABLE I.—WEATHER FACTORS INFLUENCING OYSTER PROPAGATION AT BARNEGAT, SEASON OF 1911—*Continued.*

DATE	Hour.	Fah.	Sky.	Wind.	Force.	Tide.	Phase.	Remarks.
June 23	1:00 p. m.	86°		N. E.	Weak.	4	Low	Greenheads bad.
" 23	4:00 p. m.	92°		N. W.	Var.	8.5	Flood	Nereids swimming.
" 23	7:00 p. m.	....			Calm.	12	High	Mosquitoes bad.
" 24	5:30 a. m.	70°		E.	Strong.	13	High	Heavy wind in night.
" 24	9:30 a. m.	70°		E.	Mod.	9.5	Ebb	
" 24	1:00 p. m.	....		E.	Mod.	5.5	Ebb.	
" 24	6:30 p. m.	74°		E.	Mod.	11	Flood.	
" 24	8:00 p. m.	....		S. E.	Mod.	13		
" 24	10:00 p. m.	70°		S. E.	Mod.	11	Ebb.	
" 25	9:00 a. m.	72°	Threat.	S. E.	Mod.	11	Ebb.	
" 25	7:30 p. m.	70°	Fog	E.	Mod.	14	Flood.	
" 26	6:00 a. m.	70°	Fog	E.	Weak.	9.5	Flood.	
" 26	7:30 a. m.	70°	Fog	E.	Weak.	11	Flood.	
" 26	9:30 a. m.	72°	Clear'g	E.	Weak.	12	Ebb	Tide above 13 last night.
" 26	12:30 p. m.	77°	Cloudy	E.	Weak.	9	Ebb.	
" 26	2:30 p. m.	80°	Clear'g	E.	Weak.	7	Ebb.	
" 26	3:30 p. m.	74°	Clear	E.	Weak.	6½	Low.	
" 26	7:00 p. m.	74°	Rain	E.	Weak.	11	Flood.	
" 27	7:00 a. m.	70°	Fog	S. E.	Weak.	11	Flood.	
" 27	11:15 a. m.	76°	Clear'g	S. E.	Weak.	11	Ebb.	
" 27	3:00 p. m.	80°	Clear	S.	Mod.	8.5	Flood.	
" 27	6:30 p. m.	80°	Rain	N. W.	Var.	8.5		
" 28	7:00 a. m.	78°	Clear	N. W.	Mod.	10	Flood	Heavy rain in night.
" 28	10:00 a. m.	87°	Clear	N. W.	Var.	13	Flood.	
" 28	12:15 p. m.	90°	Clear	N. W.	Var.	11.5		
" 28	4:30 p. m.	84°	Clear	S. E.	Mod.	8.5	Ebb.	
" 28	7:15 p. m.	81°	Clear		Calm.	8	Flood	Two wind storms at night.
" 29	7:30 a. m.	75°	Clear	N. E.	Mod.	9.5	Flood.	

TABLE I.—WEATHER FACTORS INFLUENCING OYSTER PROPAGATION AT BARNEGAT, SEASON OF 1911—*Continued.*

DATE	Hour.	Fah.	Sky.	Wind.	Force.	Tide.	Phase.	Remarks.
June 29	10:30 a. m.	73°	Clear	N. E.	Mod.	11.5	Flood.	
" 29	4:30 p. m.	78°	Clear	S. E.	Mod.	7	Ebb.	
" 29	7:00 p. m.	76°			Calm.	6.5	Low	Wind turns W.
" 30	7:00 a. m.	68°	Clear	N. E.	Firm.	9	Flood.	
" 30	2:00 p. m.	78°	Clear	N. E.	Firm.	11.5	High.	
" 30	5:00 p. m.	79°	Clear	S.	Firm.	7.5	Ebb.	
" 30	8:00 p. m.	72°	Clear	S. W.	Weak.	5	Low	New moon.
July 1	7:00 a. m.	74°	Clear	N.	Weak.	8	Ebb.	
" 1	9:00 a. m.	78°	Clear	E.	Weak.	7	Low.	
" 1	11:30 a. m.	81°	Clear	E.	Mod.	9	Flood.	
" 1	1:30 p. m.	84°	Clear	E.	Weak.	10	Flood.	
" 1	3:30 p. m.	84°	Clear	S.	Mod.	9.5	Ebb.	
" 1	5:30 p. m.	82°	Clear	S.	Mod.	6.5	Ebb.	
" 1	7:30 p. m.	77°	Clear	S. W.	Mod.	5	Ebb.	
" 2	7:15 a. m.	75°	Clear	S. W.	Mod.	5.5	Ebb.	
" 2	11:30 a. m.	89°	Clear	S. W.	Mod.	5	Flood.	
" 2	2:00 p. m.	91°	Cloudy	S. W.	Mod.	8	Flood.	
" 2	5:15 p. m.	86°	Rain	S. W.	Mod.	6.5	Ebb.	
" 3	6:00 a. m.	75°	Clear	S. W.	Mod.	6	Ebb.	
" 3	9:15 a. m.	89°	Clear	S. E.	Weak.	5	Ebb.	
" 3	12:00 noon.	89°	Clear	S.	Mod.	4	Flood.	
" 3	2:00 p. m.	90°	Clear	S. W.	Mod.	6	Flood.	
" 3	4:00 p. m.	85°	Clear	S. W.	Strong.	7	Flood.	
" 3	6:15 p. m.	81°	Clear	S. W.	Strong.	5	Ebb	Hard blow from S. at night.
" 4	5:30 a. m.	75°	Clear	S. W.	Weak.	6.5	Ebb.	
" 4	12:30 p. m.	85°	Clear	S. W.	Strong.	0.5	Low.	
" 4	2:00 p. m.	85°	Clear	S. W.	Strong.	1	Flood	Wind keeps strong all night.
" 5	4:30 a. m.	74°	Cloudy	S. W.	Firm.	3	Flood	Near high.

TABLE I.—WEATHER FACTORS INFLUENCING OYSTER PROPAGATION AT BARNEGAT, SEASON OF 1911—*Continued.*

DATE		Hour.	Fah.	Sky.	Wind.	Force.	Tide.	Phase.	Remarks.
July	5	8:00 a. m.	80°	Clear	S. W.	Mod.	1	Ebb.	
"	5	9:00 a. m.	83°	Clear	W.	Mod.	0.5	Ebb.	
"	5	1:00 p. m.	90°	Clear	S. W.	Strong.		Low	Tide, minus 2.
"	5	3:00 p. m.	90°	Clear	S. W.	Strong.		Flood	Tide, minus 1.5.
"	6	7:30 a. m.	82°	Clear	W.	Strong.	0.5		
"	6	9:00 a. m.	86°	Clear	S. W.		1	Ebb.	
"	6	2:00 p. m.	90°	Clear				Low	Tide, minus 3.
"	6	5:00 p. m.	89°	Clear	S. W.			Low	Tide still minus 3.
"	6	8:00 p. m.			S. W.	Gale.	0	Flood	Water very rough.
"	7	6:30 a. m.	78°	Clear	N. W.	Weak.	2	Flood	Transplanted bay.
"	7	9:00 a. m.	84°	Hazy	N. E.	Mod.	1.5	Ebb	Oysters filled up again and nearly mature.
"	7	12:00 noon.	80°	Hazy	E.	Strong.	1	Ebb	
"	7	3:30 p. m.	79°		S. E.	Strong.	1½	Flood.	
"	7	7:00 p. m.	75°		E.	Strong.	5	Flood.	
"	8	6:30 a. m.	72°	Hazy	E.	Firm.	5	Flood	Only fert. exp't that produced shelled fry.
"	8	4:00 p. m.	80°	Hazy	S. E.	Mod.	1.5	Low	
"	8	6:00 p. m.	78°	Cloudy	S. E.	Mod.	5	Flood.	
"	9	6:30 a. m.	76°	Cloudy	E.	Calm.	3	Flood	Tide turns at 9:00 a. m.
"	9	11:00 a. m.	78°	Clear'g	S. E.	Weak.	1.5	Ebb	Wind turns S. to W.
"	9	3:00 p. m.	82°	Clear	S.	Strong.		Ebb	Tide, minus 2.
"	9	5:50 p. m.	86°	Clear	S. W.	Strong.		Flood	Tide, minus 2.
"	9	9:00 p. m.	81°	Clear	S. W.	Mod.	4	Flood	Near high.
"	10	6:00 a. m.	78°	Clear	W.	Mod.	1	Flood.	
"	10	10:00 a. m.	92°	Clear	S.	Strong.	2.5	Ebb	Wind was near calm.
"	10	1:00 p. m.	92°	Clear	S.	Strong.		Ebb	Tide, minus one-half.
"	10	6:00 p. m.	86°	Threat.	W.		0	Flood	Full moon.
"	11	6:00 a. m.	77°	Clear	N. W.	Weak.	2.5	Flood.	
"	11	12:30 p. m.	96°		N. W.	Weak.	3	Ebb.	

TABLE I.—WEATHER FACTORS INFLUENCING OYSTER PROPAGATION AT BARNEGAT, SEASON OF 1911—*Continued.*

DATE	Hour.	Fah.	Sky	Wind.	Force.	Tide.	Phase.	Remarks.
July 11	5:30 p. m.	90°	Clear	N. W.	Mod.	1	Flood.	
" 11	7:30 p. m.	86°		W.	Mod.	4	Flood.	
" 12	7:00 a. m.	82°	Cloudy	W.	Mod.	3.5	Flood.	
" 12	9:00 a. m.	78°	Rain	N. W.	Weak.	6	Flood.	
" 12	10:20 a. m.	78°	Rain	W.	Weak.	7	High.	
" 12	1:00 p. m.	80°	Mist	N.	Calm.	5	Ebb.	
" 12	6:00 p. m.	80°	Clear'g	S. W.	Weak.	2.5	Flood.	
" 13	6:30 a. m.	75°	Clear	W.	Weak.	3.5	Flood	Transplanted bay oysters have spawned.
" 13	9:30 a. m.	80°	Hazy	N. E.	Mod.	6.5	Flood.	
" 13	11:00 a. m.	81°	Cloudy	N. E.	Firm	7	High.	
" 13	5:00 p. m.	83°	Clear	S.	Mod.	1	Ebb	Wind was S. E.
" 13	7:00 p. m.	78°		S.	Weak.	2	Flood.	
" 14	6:00 a. m.	78°	Rain	E.	Weak.	4	Ebb	Thunder shower.
" 14	9:00 a. m.	....		E.		5	Flood	Wind had been S. W., S., N.
" 14	11:00 a. m.	....		S. E.	Mod.	7	High.	
" 14	4:00 p. m.	....			Calm.	3.5	Still	Wind had been S. W.
" 14	Evening.	Cold	Threat.	E.	Strong.			Wind had been strong S. E.
" 15	7:30 a. m.	72°	Clear	E.	Weak.	3.5	Ebb	Tide, low at 8:00 a. m.
" 15	11:30 a. m.	79°		S. E.	Mod.	0.5	Flood.	
" 15	1:00 p. m.	80°		S.	Mod.	7	Ebb.	
" 15	4:30 p. m.	....		S. W.	Firm.	3	Ebb.	
" 15	7:00 p. m.	77°	Cloudy	S. W.	Mod.	1	Ebb.	
" 16	7:00 a. m.	76°			Calm.	4.5	Ebb.	
" 16	10:30 a. m.	80°		S. E.	Weak.	5	Flood.	
" 16	1:00 p. m.	80°		S. E.	Weak.	7.5	High.	
" 16	7:00 p. m.	79°		S.	Mod.	3.5	Ebb.	
" 17	5:00 a. m.	74°	Clear	S. E.	Weak.	7	Ebb.	
" 17	12:00 noon.	78°	Threat.	S. E.	Strong.	7	Flood	Heavy rain, 2:00 to 4:00 p. m.

TABLE I.—WEATHER FACTORS INFLUENCING OYSTER PROPAGATION AT BARNEGAT, SEASON OF 1911—*Continued.*

DATE	Hour.	Fah.	Sky.	Wind.	Force.	Tide.	Phase.	Remarks.
July 17	6:30 p. m.	75°	Clear'g	S. W.	Weak.	7	Ebb	Tide 11 at 4:00 p. m.
" 18	5:00 a. m.	64°	Clear	N. W.	Weak.	10	Ebb.	
" 18	12:00 noon.	80°	Cloudy	N. W.	Strong.	10	Flood.	
" 18	6:30 p. m.	78°	Cloudy	N. W.	Weak.	8	Ebb.	
" 19	6:00 a. m.	61°	Clear	N. W.	Weak.	7	Ebb.	
" 19	12:15 p. m.	83°	Clear	E.	Weak.	5.5	Flood	Tide 8 at 5:00 p. m.
" 19	7:00 p. m.	75°	Cloudy	S.	Mod.	5.5	Ebb.	
" 20	6:30 a. m.	72°	Threat.	S. W.	Mod.	5	Flood	Near high.
" 20	10:30 a. m.	78°	Rain	N. W.	Strong.	3	Low.	
" 20	2:00 p. m.	74°	Clear'g	S. W.		5	Flood.	
" 20	5:00 p. m.	77°		S. W.	Strong.	6.5	Ebb.	
" 20	7:30 p. m.	77°	Clear'g	S. W.	Strong.	5.5	Ebb.	
" 21	7:30 a. m.		Clear'g		Calm.			Heavy rain 2:30 a. m.
" 21	9:30 a. m.	77°	Threat.	N. E.		5	Flood	Wind S. W. at noon.
" 21	8:00 p. m.	71°			Calm.	11	Ebb	Heavy storm p. m.
" 22	6:00 a. m.	70°	Clear	N.	Weak.	9	Ebb.	
" 22	10:00 a. m.	78°	Clear	N. E.	Var.	6	Ebb.	
" 22	2:30 p. m.	73°	Clear	N.	Var.	5.5	Flood.	
" 22	8:00 p. m.		Clear	N.	Weak.	11	Ebb	Tide was near 13.
" 23	8:00 a. m.	74°	Clear	N. W.	Mod.	7	Ebb.	
" 23	1:00 p. m.	76°	Clear	W.	Mod.	3	Low.	
" 23	2:30 p. m.	88°	Clear	N. W.	Mod.	3	Flood.	
" 23	6:00 p. m.	79°	Clear	S. W.	Strong.	7	Flood.	
" 24	5:30 a. m.	77°	Cloudy	S.	Strong.	5	Flood	Heavy rain until 9:00 a. m., followed by high wind.
" 24	2:30 p. m.	89°		S. W.	Strong.	2.5	Low.	
" 24	7:00 p. m.	80°		S. W.	Strong.	10.5	Flood	Near high.
" 25	5:30 a. m.	67°	Clear	W.	Weak.	8	Flood.	
" 25	10:30 a. m.	75°	Clear	W.	Strong.	8	Ebb.	

TABLE I.—WEATHER FACTORS INFLUENCING OYSTER PROPAGATION AT BARNEGAT, SEASON OF 1911—*Continued.*

DATE	Hour.	Fah.	Sky.	Wind.	Force.	Tide.	Phase.	Remarks.
July 25	4:00 p. m.	83°	Clear	N. W.	Mod.	4	Flood.	
" 26	6:00 a. m.	66°	Clear		Calm.	5	Flood	
" 26	11:30 a. m.	78°	Cloudy	S. W.	Weak.	7	Ebb	Tide, high at 9:30.
" 26	1:00 p. m.	70°	Rain	N.	Weak.	6	Ebb.	
" 26	5:00 p. m.	80°	Clear'g	S. E.	Mod.	8	Flood.	
" 26	8:00 p. m.	70°	Clear'g	S. E.	Weak.	7	Flood.	
" 27	6:00 a. m.	67°	Hazy	N.	Calm.	5	Flood.	
" 27	3:30 p. m.	78°	Hazy	N. E.	Mod.	5.5	Ebb.	
" 28	6:00 a. m.	70°	Rain	N. E.	Firm.	8	Ebb.	
" 28	3:00 p. m.	75°	Clear'g	N. W.	Weak.	8.5	Ebb	Tide 5 at 7:30 p. m.
" 28	9:00 p. m.	70°	Clear	S. W.	Weak.	7	Flood	New moon.
" 29	7:00 a. m.	68°	Clear	S. W.	Weak.	5	Ebb.	
" 29	12:30 p. m.	80°	Clear	S.	Mod.	7	High.	
" 29	6:30 p. m.	78°	Hazy	S. W.	Firm.		Ebb	Tide, minus one-half.
" 30	7:30 a. m.	72°	Cloudy	S. W.	Weak.	3.5	Ebb	Tide, low at 9:00 a. m.
" 30	10:30 a. m.	80°	Clear'g	N. E.	Weak.			Wind had been W., N. W., N.
" 30	1:30 p. m.	80°	Hazy	E.	Weak.	7	High.	
" 30	6:00 p. m.	77°	Threat.	S. W.	Weak.	4	Ebb.	
" 31	5:00 a. m.	72°	Clear'g	N. W.	Weak.	5	Ebb.	
" 31	9:30 a. m.	82°		N. E.	Weak.			
" 31	6:30 p. m.	83°	Clear		Calm.			At Forked River until Aug. 5th.
Aug. 1	6:30 a. m.	67°	Clear		Calm.			
" 1	1:00 p. m.	82°	Clear	S. E.	Mod.			
" 1	8:00 p. m.	78°	Clear	S. E.	Weak.			
" 2	5:30 a. m.	68°	Clear		Calm.			
" 2	2:30 p. m.	83°	Clear	S. E.	Mod.			
" 2	8:00 p. m.	78°	Cloudy	E.	Weak.			
" 3	6:30 a. m.	78°	Clear	E.	Mod.			

TABLE I.—WEATHER FACTORS INFLUENCING OYSTER PROPAGATION AT BARNEGAT, SEASON OF 1911—*Continued.*

DATE	Hour.	Fah.	Sky.	Wind.	Force.	Tide.	Phase.	Remarks.
Aug. 3	1:00 p. m.	84°	Clear	E.	Strong.			
" 3	6:00 p. m.	80°	Cloudy	E.	Strong.			
" 4	5:30 a. m.	72°	Cloudy	E.	Weak.			
" 4	12:00 noon.	....	Cloudy	E.	Mod.			
" 4	8:00 p. m.	73°	Cloudy	E.	Weak.			
" 5	6:15 a. m.	69°	Clear	.....	Calm.	......	Ebb	At Forked River.
" 5	8:00 a. m.	78°	Clear	E.	Weak.	......	Ebb	Ebb at 11:00 a. m.
" 5	3:30 p. m.	81°	Clear	S. E.	Mod.	6	Flood.	
" 5	6:00 p. m.	....	.....	.....	.....	8	Flood	Tide 10 at 7:00 p. m., high.
" 6	6:30 a. m.	70°	Clear	N. W.	Calm.	8	Flood	Wind turns N.
" 6	8:00 a. m.	76°	.....	S. E.	Weak.	7.5	Ebb	Tide high at 7:00 a. m.
" 6	11:00 a. m.	82°	.....	S. E.	Weak.	5	Ebb.	
" 6	2:00 p. m.	86°	.....	S. E.	Weak.	3.5	Flood	Tide low at 1:00 p. m.
" 6	6:00 p. m.	79°	Clear	S.	Weak.	8	Flood.	
" 7	7:00 a. m.	70°	Threat.	N. E.	Mod.	8.5	Flood	Tide high, 9.5, at 8:00 a. m.
" 7	3:00 p. m.	86°	Clear'g	E.	Weak.	5	Flood.	
" 8	8:00 a. m.	74°	Clear	S. E.	Weak.	10	Flood	Full moon; high at 9:00 a. m.
" 9	7:00 a. m.	75°	Cloudy	S. W.	Mod.	9	Flood.	
" 9	3:30 p. m.	82°	Cloudy	S. W.	.....	5	Low.	
" 10	7:30 a. m.	75°	Clear	N. E.	Weak.	10.5	Flood	Tide 11 at 9:30 a. m.
" 10	3:00 p. m.	88°	Clear	S. W.	Mod.	7	Ebb.	
" 10	6:00 p. m.	85°	Clear	S. W.	Mod.	5.5	Flood.	
" 11	5:15 a. m.	78°	Clear	W.	Mod.	5.5	Low.	
" 11	12:00 noon.	93°	Clear	W.	Strong.	6	Flood.	
" 11	6:00 p. m.	90°	Clear	W.	Weak.	4	Low	95° at 1:30 p. m.
" 12	5:00 a. m.	75°	Cloudy	N. E.	Strong.	9.5	Ebb	Heavy storm last night.
" 12	1:30 p. m.	81°	Clear	N. E.	Mod.	11	High.	
" 12	6:30 p. m.	79°	Clear	E.	Weak.	6	Ebb.	
" 13	8:00 a. m.	70°	Cloudy	N. W.	Weak.	6.5	Flood	Tide 10 at 11:00 a. m.

TABLE I.—WEATHER FACTORS INFLUENCING OYSTER PROPAGATION AT BARNEGAT, SEASON OF 1911—*Continued.*

DATE	Hour.	Fah.	Sky.	Wind.	Force.	Tide.	Phase.	Remarks.
Aug. 13	2:00 p. m.	76°	Rain	S. W.	Weak.	5	Ebb.	
" 13	11:00 p. m.	70°	Clear'g		Calm.	11	High.	
" 14	6:00 a. m.	68°	Fog	N. W.	Weak.	6	Ebb	Near low.
" 14	12:00 noon.	82°	Clear	E.	Weak.	9	Flood	Near high.
" 14	6:00 p. m.	83°	Clear	S. W.	Strong.	4	Ebb.	
" 15	8:00 a. m.	75°	Cloudy.	W.	Mod.	4.5	Flood.	
" 15	12:00 noon.	85°	Clear'g	S. W.	Strong.	8	Flood.	
" 15	6:00 p. m.	76°	Rain	W.	Strong.	8.5	Ebb	Thunder storm at 4:00 p. m.
" 16	6:30 a. m.	71°	Clear	N. W.	Strong.	5	Ebb.	
" 16	11:30 a. m.	85°	Clear	N.	Strong.	8	Flood.	
" 16	6:00 p. m.	90°		N. W.	Weak.	7	Ebb.	
" 17	9:30 a. m.	81°	Clear'g	N. W.	Mod.	8	Ebb	Near low.
" 17	1:30 p. m.	92°	Hazy	N. W.	Firm.	8	Flood	Bay plants are empty of spawn.
" 17	6:00 p. m.	82°	Rain	S. W.	Weak.	9		
" 18	9:00 a. m.	74°	Cloudy	S.	Weak.	4	Ebb	Heavy storm.
" 18	11:00 a. m.	75°	Clear'g	S. W.	Firm.	1.5	Ebb.	
" 18	4:00 p. m.	85°	Clear'g	W.	Strong.	7	Flood	Heavy storm at 4:30 p. m.
" 18	7:30 p. m.	69°	Clear	N. W.	Weak.	8	Ebb.	
" 19	5:00 a. m.	60°		N. W.	Mod.	4	Flood	Natural oysters filling up with spawn again.
" 19	3:00 p. m.	80°		N. W.	Strong.	4	Flood.	
" 19	6:00 p. m.	78°	Clear	N. W.	Weak.	6	Flood.	
" 20	8:30 a. m.	71°	Clear	N.	Weak.	3	Ebb.	
" 20	11:30 a. m.	77°	Clear	S. E.	Weak.	1	Low	Tide 5 flood at 3:00 p. m.
" 20	11:00 p. m.	65°	Clear	S. W.	Weak.	3	Flood.	
" 21	6:00 a. m.	58°	Clear	N.	Weak.	5.5	Flood	High at 7:30 a. m.
" 21	1:00 p. m.	80°	Clear	N. E.	Mod.	2	Low.	
" 21	6:30 p. m.	72°	Clear	S. W.	Mod.	5.5	Flood.	
" 22	7:00 a. m.	64°	Clear	N.	Weak.	6.5	Near high.	Wind E. at 8:30 a. m.
" 22	12:00 noon.	78°	Cloudy	S. E.	Mod.	4	Ebb	Rain in p. m.

TABLE 1.—WEATHER FACTORS INFLUENCING OYSTER PROPAGATION AT BARNEGAT, SEASON OF 1911—*Continued.*

DATE	Hour.	Fah.	Sky.	Wind.	Force.	Tide.	Phase.	Remarks.
Aug. 22	6:30 p. m.	78°	Clear'g	N. E.	Mod.	7	Flood.	
" 23	8:00 a. m.	70°	Clear	S. W.	Mod.	7	Flood	Ebb at 9:00 a. m.
" 23	2:30 p. m.	88°	Clear	S. W.	Strong.	2.5	Ebb.	
" 23	4:00 p. m.	87°	Clear	S. W.	Strong.	1	Low	Rain at 7:00 p. m.
" 24	6:30 a. m.	74°	Clear'g	N. E.	Mod.	6.5	Flood.	
" 24	8:00 a. m.					8.5	Flood	High at 9:30 a. m.
" 24	9:00 p. m.	73°	Cloudy	N. E.	Strong.			
" 25	8:00 a. m.	77°	Clear'g		Calm.	8.5	Flood	Storm last night.
" 25	10:00 a. m.	81°				11.5	Flood.	
" 25	9:00 p. m.	76°	Rain	N. E.				
" 26	6:30 a. m.	74°	Rain	S. W.		9	Flood.	
" 26	1:00 p. m.	81°	Rain	E.	Weak.	13	Ebb	Heavy rains in p. m.
" 26	6:30 p. m.	75°	Rain	S. E.	Weak.			
" 27	6:30 a. m.	75°	Fog		Calm.	9.5	Ebb	Rainy night.
" 27	12:00 noon.	77°	Rain	N.	Strong.	15	Flood	Tide 18 at 3:30 p. m.
" 27	6:00 p. m.	75°	Rain	E.	Gale.	11	Ebb.	
" 28	6:00 a. m.	75°	Clear'g	S. W.	Weak.	9	Ebb.	
" 28	12:00 noon.	81°	Clear	S. W.	Strong.	9.5	Flood.	
" 28	6:00 p. m.	80°	Clear	S. W.	Strong.	5.5	Ebb.	
" 29	7:00 a. m.	78°	Clear'g	S. W.	Strong.	8	Ebb	Blew hard all night.
" 29	12:30 p. m.			S. W.	Strong.	10	Flood	N. W. showers.
" 29	2:00 p. m.	80°	Rain	N. E.		11	Flood	Tide 9.5 at 11:00 a. m.
" 29	3:30 p. m.	74°	Clear	N. E.		15	High	4:00 p. m. tide is 14.
" 30	9:00 a. m.			S. W.	Strong.	7	Low.	
" 30	4:00 p. m.					14	Ebb.	
" 31	6:00 a. m.		Rain	N. E.	Strong.	17.5	Ebb	Tide 18.5 at 10:30 a. m.
" 31	2:30 p. m.		Rain	N. E.	Strong.	23	Flood.	
" 31	4:00 p. m.					22.5	Ebb	Tide 19.5 at 6:30 p. m.
Sept. 1	5:30 p. m.	62°		N.	Weak	13	Ebb.	

TABLE II.—EXAMINATION OF WATER OF OYSTER BEDS AT BARNEGAT, SEASON OF 1911.

Date.	Hour.	Place.	L.	Tide.	H.	Density.	Temp.	Phase.	Fry.	Remarks.
June 11	11:30 a. m	O't	6	7	11	1017	77°	Ebb	16	Half are small.
" 11		E. C. I.				1014	77°	Ebb	11	Third are medium
" 12	10:00 a. m.	O't	7	11	12	1016	74°	Flood	356	
" 12	10:00 a. m.	H. P.				1016.5	74°	Flood	220	175 at E. C. I.
" 13	9:30 a. m.	H. P.	8	11.5	13	1016	73°	Flood	8	
" 13	9:30 a. m.	O't				1016.5		Flood	496	1 cl., 6 at H. P.
" 13	9:30 a. m.	E. C. I.				1013.5		Flood	750	
" 13	3:00 p. m.	O't		9.5				Ebb	3	At intervals from H. P. across
" 13	3:00 p. m.	O't						Ebb	6	channel.
" 13	3:00 p. m.	O't						Ebb	36	Mid channel.
" 13	3:00 p. m.	O't						Ebb	21	Northward.
" 13	3:00 p. m.	O't						Ebb	19	Near piling.
" 13	6:00 p. m.	E. C. I.		9.5		1015	73°	Flood	..	
" 14	8:00 a. m.	O't	7.5	11	13	1017	72°	Flood	22	
" 14	8:00 a. m.	E. C. I.				1015.5	72°	Flood	4	
" 14	11:00 a. m.	O't		13		1018	75°	High	26	
" 14	11:00 a. m.	E. C. I.				1016	75°	High	10	
" 14	3:00 p. m.	O't		10		1017	73°	Ebb	8	
" 14	3:00 p. m.	E. C. I.				1014.5	75°	Ebb	1	
" 15	9:15 a. m.	O't	7	9	12	1017.5	71°	Flood	2	
" 15	9:15 a. m.	E. C. I.				1016	71°	Flood	4	
" 15	2:15 p. m.	O't		11		1017.5	73°	Ebb	0	Great wind storm at 5 p. m.
" 15	2:15 p. m.	E. C. I.				1014	73°	Ebb	4	
" 16	9:30 a. m.	O't	7	8.5	1[illegible]	1017	70°	Flood	4	
" 16	9:30 a. m.	E. C. I.				1014.5		Flood	0	
" 17	8:00 a. m.	O't	6	6.5	10	1017	65°	Ebb	0	Natural oysters have partly
" 17	8:00 a. m.	E. C. I.				1016	66°	Ebb	0	spawned, but not the large
" 17	10:00 a. m.	E. C. I.		6.5				Flood	0	Bays.

TABLE II.—EXAMINATION OF WATER OF OYSTER BEDS AT BARNEGAT, SEASON OF 1911—*Continued.*

Date.	Hour.	Place.	L.	Tide.	H.	Density.	Temp.	Phase.	Fry.	Remarks.
June 17	11:15 a. m.	O't		7.5		1017	72°	Flood		
" 17	11:15 a. m.	E. C. I.				1015	72°	Flood		Commencement break.
" 22	8:00 p. m.	O't				1017	73°		188	
" 22	8:00 p. m.	E. C. I.				1016.5	72°		162	On course.
" 23	10:30 a. m.	W. L. C.	4	8.5	12	1014.2	78°	Ebb	118	On course.
" 23	10:30 a. m.	E. C. I.				1013.2		Ebb	270	On course.
" 23	10:30 a. m.	E. B. C.				1014		Ebb	171	On course.
" 23	12:30 p. m.	N. O't		6		1014	82°	Ebb	85	On course after standing.
" 23	12:30 p. m.	S. O't						Ebb	140	On course.
" 23	3:30 p. m.	E C. I.		7		1015.2	80°	Flood	78	Much debris.
" 23	4:00 p. m.	O't		9		1016	80°	Flood	570	
" 23	6:00 p. m.	E. C. I.		11		1017	68°	Flood	271	Over night in lake.
" 23	6:00 p. m.	O't				1017.2	68°	Flood	405	Over night in lake.
" 24	Noon.	O. Sl.	4.5	6.5	13	1015.7	72°	Ebb	*277	On course N. E.
24	Noon.	E. Sl.						Ebb	415	On course mostly S., much debris.
" 24	Noon.	F.						Ebb	80	On course mostly S., debris.
" 24	Noon.	O. Lt.				1016.2	75°	Ebb	56	On course mostly S., debris.
" 24	8:00 p. m.	Ph. Cl.		13		1016.7	68°	High	14	On course W.
" 24	8:00 p. m.	F.				1016.7	68°		16	On course W.
" 24	8:00 p. m.	F.				1016.7	68°		8	On course W.
" 24	8:00 p. m.	H. St.				1016.7	68°		26	On course W.
" 24	8:00 p. m.	E. C. I.				1016.7	68°		56	Bay water O. food.
" 26	6:30 a. m.	S. st.	6.5	10	14	1015	69°	Flood	5	Circular course from S. St. to B't Cl. beyond sloop.
" 26	6:30 a. m.	F.				1015	70°	Flood	Lost.	
" 26	6:30 a. m.	Ph. Cl.				1014.2	70°	Flood	2	
" 26	6:30 a m.	B't Cl.				1014.6	70°	Flood	1c	Barrel infusors.
" 26	7:00 a. m.	E. C I.		11		1015	70°	Flood	14	
" 26	Noon.	E. C. I.		9		1013	74°	Ebb	1	

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*The height of the tide is given in inches at the designated time. In colum "L." the height at low water is entered for that day; and in column "H." the maximum height for high water.

TABLE II.—EXAMINATION OF WATER OF OYSTER BEDS AT BARNEGAT, SEASON OF 1911—*Continued.*

Date.	Hour.	Place.	L.	Tide.	H.	Density.	Temp.	Phase.	Fry.	Remarks.
June 26	2:00 p. m.	S. st.	....	7	....	1014.3	75°	Ebb	3	On course S. to N.
" 26	2:00 p. m.	F.	....	....	....	1014.5	75°	Ebb	9	
" 26	2:00 p. m.	B't Cl.	....	....	....	1014	75°	Ebb	3	
" 26	2:00 p. m.	O't	....	....	....	1014.5	75°	Ebb	2	
" 26	6:00 p. m.	E. C. I.	....	10	....	....	....	Flood	8	
" 26	6:00 p. m.	O't	....	....	....	....	....	Flood	1	
" 27	8:00 a. m.	O't	6.5	12	13	....	....	Flood	0	
" 27	8:00 a. m.	W. L. C.	....	....	....	....	....	Flood	0	
" 27	11:15 a. m.	O't	....	11	....	1013	77°	Ebb	10	
" 27	11:15 a. m.	E. C. I.	....	....	....	1013.4	77°	Ebb	1	
" 27	3:00 p. m.	O't	....	8.5	....	1010.3	80°	Ebb	0	
" 27	3:00 p. m.	E. C. I.	....	....	....	1010.3	80°	Ebb	14	
" 28	12:15 p. m.	O't	7	11.5	13	1015	80°	Ebb	8	
" 28	1:30 p. m.	E. C. I.	....	10.5	....	1013	83°	Ebb	10	
" 28	4:30 p. m.	O't	....	8.5	....	1014	83°	Ebb	22	
" 28	4:30 p. m.	E. C. I.	....	....	....	1013	83°	Ebb	40	
" 29	Noon.	E. C. I.	6.5	11	12	1013.3	82°	Flood	76	
" 29	7:00 p. m.	E. C. I.	....	6.5	....	....	....	Low	9	
" 29	7:00 p. m.	Sl.	....	....	....	....	....	Low	44	
" 29	7:00 p. m.	Sl.	....	....	....	bot.	....	Low	28	Much debris, brown.
" 30	2:00 p. m.	Sl.	5	11.5	12	bot.	....	High	....	Too much debris.
" 30	2:00 p. m.	Sl.	....	....	....	....	....	High	251	
" 30	2:00 p. m.	E. C. I.	....	....	....	....	....	High	474	
" 30	7:15 p. m.	Sl.	....	6	....	....	....	Ebb	163	
" 30	7:15 p. m.	E. C. I.	....	....	....	....	....	Ebb	11	Few only are med.
July 1	7:30 a. m.	E. C. I.	4	8	11	1014	75°	Ebb	20	
" 1	9:30 a. m.	E. C. I.	....	7	....	1015	78°	Flood	65	
" 1	11:30 a. m.	E. C. I.	....	9	....	1015	79°	Flood	389	

TABLE II.—EXAMINATION OF WATER OF OYSTER BEDS AT BARNEGAT, SEASON OF 1911—*Continued.*

Date.	Hour.	Place.	L.	Tide.	H.	Density.	Temp.	Phase.	Fry.	Remarks.
July 1	1:30 p. m.	E. C. I.	....	10	....	1016	81°	Flood	734	
" 1	3:30 p. m.	E. C. I.	....	9.5	....	1016	82°	Ebb	368	
" 1	5:30 p. m.	E. C. I.	....	6.5	....	1015	82°	Ebb	153	
" 1	7:30 p. m.	E. C. I.	....	5	....	1015	80°	Ebb	101	
" 3	10:15 a. m.	C.	3	4	7	....	......	Ebb	30	
" 3	2:00 p. m.	C.	....	6	....	1014	88°	Flood	19	
" 4	6:00 a. m.	E. C. I.	0.5	5.5	7	1010.5	77°	Ebb	5	1, clam.
" 4	6:00 a. m.	O't	....	....	....	1015.1	78°	Ebb	167	5, clam.
" 5	8:00 a. m.	Sl.	m 2	1	4	1011.5	84°	Ebb	956	
" 5	8:00 a. m.	O. Lt.	....	....	....	1013.5	83°	Ebb	3,256	N. oyster beds.
" 6	9:30 a. m.	Br.	m 3	1	2	1012.7	85°	Ebb	415	Circuit S. to Ph. Cl.
" 6	9:30 a. m.	F.	....	....	....	1013.6	85°	Ebb	1,070	
" 6	9:30 a. m.	F.	....	....	....	1013.8	85°	Ebb	2,180	
" 6	9:30 a. m.	F.	....	....	....	1013.2	85°	Ebb	2,640	
" 6	9:30 a. m.	Ph. Cl.	....	....	....	1013.8	85°	Ebb	2,535	
" 6	Noon.	Bay	....	m 2	....	rough.	......	Ebb	510	Circuit far out S. to N.
" 6	Noon.	F.	....	....	....	....	......	Ebb	820	
" 6	Noon.	F.	....	....	....	....	......	Ebb	2,285	
" 6	Noon.	F.	....	....	....	....	......	Ebb	1,475	
" 6	Noon.	F.	....	....	....	....	......	Ebb	640	
" 6	Noon.	F.	....	....	....	....	......	Ebb	1,150	
" 7	8:30 a. m.	Sl.	m 1	2.5	2.5	1014.7	82°	High	445	From Sl. N. E. course half are medium.
" 7	8:30 a. m.	F.	....	....	....	....	......	High	240	
" 7	8:30 a. m.	F.	....	....	....	....	......	High	665	Several large.
" 7	8:30 a. m.	F.	....	....	....	....	......	High	755	
" 7	8:30 a. m.	F.	....	....	....	....	......	High	385	
" 7	8:30 a. m.	F.	....	....	....	....	......	High	550	Most small.
" 7	Noon.	Sl. b.	....	1	....	1014.3	83°	Ebb	70	Rough, much sand (bot.).

TABLE II.—EXAMINATION OF WATER OF OYSTER BEDS AT BARNEGAT, SEASON OF 1911—*Continued.*

Date.		Hour.	Place.	L.	Tide.	H.	Density.	Temp.	Phase.	Fry.	Remarks.
July	7	Noon.	Sl. b.				1014.2	83°	Ebb	45	Florideae, &c.
"	7	Noon.	Sl. b.				1014.2	83°	Ebb	160	Much debris.
"	7	Noon.	Sl. b				1014.1	83°	Ebb	75	Brown debris (bot.).
"	7	12:30 p. m.	C.		1		1013.7		Ebb	105	
"	7	12:30 p. m	Sh.				1018.8		Ebb	180	Mixed with crate.
"	7	6:30 p. m.	O't		4				Flood	10	Strong E. wind.
"	8	8:00 a. m.	E. C. I.	1.5	7	7			High	105	
"	8	8:00 a. m.	Bay						High	30	Beyond sloop.
"	8	8:00 a. m.	Bay						High	45	Beyond sloop (bot.).
"	8	4:00 p. m.	O't		1.5				Low	6	From O't to O. Lt. on radial course.
"	8	4:00 p. m.	F.						Low	20	
"	8	4:00 p. m.	F.						Low	40	
"	8	4:00 p. m.	O. Lt.						Low	20	
"	8	4:00 p. m.	O. Lt.						Low	15	(bot.)
"	9	9:00 a. m.	E. C. I.	m 3	4	4			High	45	Fert. Expt. reached shell stage.
"	9	9:00 a. m.	S. st.						High	15	Course from S. St. to Ph. Cl.
"	9	9:00 a. m.	F.						High	50	
"	9	9:00 a. m.	F.						High	30	
"	9	9:00 a. m.	F.						High	35	Some fry large transplanted Bay oysters filled with mature spawn used for Fert. Expt.
"	9	9:00 a. m	Ph. Cl.						High	10	
"	9	11:00 a. m.	E. C. I.		2				Ebb	30	
"	9	7:00 p. m.	Bay		5				High	2	Course within stakes from S. St. to O. Lt.
"	9	7:00 p. m.	Bay						High	1	
"	9	7:00 p. m.	Bay						High	0	
"	9	7:00 p. m.	Bay						High	2	
"	10	11:00 a. m.	Sl.	m 2	1.5	4	1014	86°	Ebb	90	
"	10	11:00 a. m.	E. C. I.				1011	88°	Ebb	25	
"	11	Noon.	Cr. I.	0	min. half	5.5			Ebb	36	Medium.

TABLE II.—EXAMINATION OF WATER OF OYSTER BEDS AT BARNEGAT, SEASON OF 1911—*Continued.*

Date.	Hour.	Place.	L.	Tide.	H.	Density.	Temp.	Phase.	Fry.	Remarks.
July 11	7:30 p. m.	E. C. I.		1				Flood	435	
" 11	7:30 p. m.	Sl.							85	
" 12	10:00 a. m.	Sl.	1	7	7			High	265	Between showers.
" 12	10:00 a. m.	Sl.						High	410	Between showers (Mid.).
" 12	1:00 p. m.	E. C. I.		5				Ebb	210	Mist.
" 13	11:30 a. m.	E C. I.	1	7	7			High	615	Medium fry.
" 13	5:00 p. m.	E. C. I.		1				Low	315	
" 13	5:00 p. m.	Sl.						Low	135	
" 13	5:00 p. m.	Sl.						Low	85	Bot.
" 14	8:30 a. m.	Sl.	3	4.5	7			Flood	75	Transplanted Bay oysters have spawned.
" 14	8:30 a. m.	F.						Flood	100	
" 14	8:30 a. m.	E. C. I.						Flood	150	
" 14	11:00 a. m.	E. C. I.		7				High	75	
" 14	11:00 a. m.	Sl. b.						High	135	
" 14	4:00 p. m.	E. C. I.		3.5				Ebb	20	
" 14	4:30 p. m.	Sl. b.		3				Low	85	Strong wind.
" 14	4:30 p. m.	Sl. b.						Low	20	Mid.
" 15	8:00 a. m.	E. C. I.	3	3	7			Low	60	Extensive cultch planting.
" 15	8:00 a. m.	Sl. b.						Low	10	One ready to set.
" 15	8:00 a. m.	Sl. b.						Low	50	Mid.
" 15	11:00 a. m.	E. C. I.		6.5				Flood	95	Some are small.
" 15	11:00 a. m.	Sl. b.						Flood	75	Some are small.
" 15	11:00 a. m.	Sl. b.						Flood	145	More are small (Mid.).
" 15	1:00 p. m.	E. C. I.		7		1015	78°	Ebb	105	After standing.
" 15	1:00 p. m.	Sl. b.				1015.4	77°	Ebb	105	Mostly small.
" 15	5:00 p. m.	E. C. I.		3				Ebb		Too much debris.
" 15	5:00 p. m.	Sl. b.						Ebb	15	
" 16	7:30 a. m.	E. C. I.	3	4	7.5		78°	Ebb	40	

TABLE II.—EXAMINATION OF WATER OF OYSTER BEDS AT BARNEGAT, SEASON OF 1911—*Continued.*

Date.	Hour.	Place.	L.	Tide.	H.	Density.	Temp.	Phase.	Fry.	Remarks.
July 16	7:30 a. m.	Sl. b.	....	....	....	....	78°	Ebb	115	Weak breeze on water.
" 16	7:30 a. m.	Sl. b.	....	....	....	....	80°	Ebb	440	Most are small (Mid.).
" 16	1:00 p. m.	E. C. I.	....	7.5	....	....	84°	High	185	
" 17	5:30 a. m.	E. C. I.	3	7	8	....	......	Ebb	90	Two large.
" 17	5:30 a. m.	Sl. b.	....	....	....	....	......	Ebb	100	One ready to set.
" 17	5:30 a. m.	Sl. b.	....	....	....	....	......	Ebb	45	One large (Mid.).
" 17	4:00 p. m.	E. C. I.	....	10	....	....	......	High	5	
" 18	5:30 a. m.	E. C. I.	5	10	10	....	......	High	25	Two medium.
" 19	7:30 p. m.	E. C. I.	4	5	8	....	......	Ebb	20	
" 19	7:30 p. m.	Sl.	....	....	....	....	......	Ebb	15	
" 20	7:30 a. m.	E. C. I.	3	4	6	....	......	Ebb	0	
" 20	7:30 a. m.	Sl. b.	....	....	....	....	......	Ebb	5	1 clam fry.
" 26	6:30 a. m.	Bay	2	5.5	8	1015.9	76°	Flood	165	Bot.
" 26	6:30 a. m.	Bay	....	....	....	1012.3	72°	Flood	420	Mixed course.
" 26	7:15 a. m.	E. C. I.	....	6	....	1014.4	75°	Flood	235	Few medium.
" 26	11:00 a. m.	E. C. I.	....	7	....	1011.5	76°	Ebb	165	
" 26	Noon.	Sl. b.	....	6.5	....	1015.6	75°	Ebb	205	
" 26	Noon.	Sl. b.	....	....	....	1015	75°	Ebb	100	Bottom water.
" 30	9:30 a. m.	Sl. b.	3	3.5	7	....	......	Flood	1	Mixed course.
" 30	9:30 a. m.	Sl. b.	....	....	....	....	......	Flood	0	Mixed course (bot.).
" 30	2:30 p. m.	E. C. I.	....	6	....	1012.8	78°	Ebb	8	1 ready to set.
" 30	2:30 p. m.	Sl.	....	....	....	1015.5	78°	Ebb	0	In calm slicks.
" 31	9:00 a. m.	B. B.	3	3	7	1015.9	76°	Flood	5	From Barnegat to Forked River at mile intervals.
" 31	9:00 a. m.	F.	....	....	....	1015.8	76°	Flood	10	
" 31	9:00 a. m.	W't	....	....	....	1014.7	76°	Flood	5	
" 31	9:30 a. m.	F.	....	....	....	1013.2	77°	Flood	25	
" 31	9:30 a. m.	F.	....	....	....	1013.1	76°	Flood	10	
" 31	9:30 a. m.	F. R.	....	....	....	1011.3	78°	Flood	......	

TABLE II.—EXAMINATION OF WATER OF OYSTER BEDS AT BARNEGAT, SEASON OF 1911—*Continued.*

Date	Hour.	Place.	L.	Tide.	H.	Density.	Temp.	Phase.	Fry.	Remarks.
July 31	10:00 a. m.	F. R. b.		4		1001	80°	Flood		
Aug. 5	8:00 a. m.	F. R. b.				1002.9	77°	Ebb		From Forked River to Barnegat, at intervals up to 2 miles.
" 5	8:30 a. m.	F. R.				1003	76°	Ebb		
" 5	9:30 a. m.	W't				1012.6	78°	Ebb	1	
" 5	10:20 a. m.	F.				1015.2	79°	Ebb	0	
" 5	10:30 a. m.	Ph. Cl.				1016	77°	Ebb	0	After standing.
" 5	10:30 a. m.	E. C. I.	3	6	8	1015.8	82°	Ebb	525	Many are large; many also clams.
" 6	7:00 a. m.	Anch.	3	8	8			High	165	On course from Anch. southward.
" 6	7:15 a. m.	E. C. I.				1015.6	78°	High	80	
" 6	7:30 a. m.	Cl. F.				1015.8	78°	High	455	Bottom residue after standing, 640.
" 6	7:45 a. m.	E. B. C.		7		1015.4	80°	Ebb	20	
" 6	10:30 a. m.	Anch.				1015	84°	Ebb	25	
" 6	10:45 a. m.	Cl. F.				1013.5	83°	Ebb	60	
" 6	11:00 a. m.	O't		5		1013.5	83°	Ebb	110	On course.
" 6	2:30 p. m.	C.		3		1012.9	85°	Flood	45	In "slick."
" 6	2:30 p. m.	C. F.				1018	85°	Flood	30	
" 6	3:00 p. m.	Sl. b.				1013.5	85°	Flood	160	In "slick."
" 6	7:00 p. m.	O't		8				High	46	15 to 28 at E. C. I., &c.
" 7	8:00 a. m.	S. S.	3	8.5	9	1014.5	78°	High	25	
" 8	8:00 a. m.	Anch.	3	10	10	1014	78°	High	40	Many are large.
" 10	9:30 a. m.	Sl.	5	11	11			Flood	0	1 clam fry.
" 11	10:00 a. m.	Sl.	4	6	7			Flood	0	
" 13	11:00 a. m.	E. C. I.	4	10	11			Flood	3	2 clam fry.
" 14	Noon.	Sl.	5	9	10			Flood	5	1 medium.
" 15	1:00 p. m.		5	9	10			Flood	5	Bay plants empty.
" 17	7:00 p. m.	Anch.	6	8	9			Ebb	10	1 clam.
" 17	7:00 p. m.	Sl.						Ebb	6	1 large, 1 clam.
" 20	3:15 p. m.	E. C. I.	1	3	7			Flood	10	Naturals filling.

TABLE II.—EXAMINATION OF WATER OF OYSTER BEDS AT BARNEGAT, SEASON OF 1911—*Continued.*

Date.	Hour.	Place.	L.	Tide.	H.	Density.	Temp.	Phase.	Fry.	Remarks.
Aug. 21	7:30 a. m.	Sl.	1	3	6			Ebb	8	1 medium, 2 large.
" 22	8:30 a. m.	E. C. I.	3	5	7			Ebb	5	2 medium, 1 clam.
" 23	7:00 p. m.	Anch.	1	4	7			Flood	2	1 medium., 1 large, 3 clams.
" 24	9:30 a. m.	Anch.	2	9	9			High	8	3 medium, 5 clams.
" 24	9:30 a. m.	Sl.						High	4	2 medium. 5 clams.
" 25	10:00 a. m.	Anch.	5	12	12			High	0	1 clam.
" 25	10:00 a. m.	Sl.						High	5	2 clams.
" 25	10:00 a. m.	Sl.						High	20	Half medium, 6 clams.
" 29	9:00 a. m.	C.				1005	81°	Low		
" 29	9:30 a. m.	Anch.				1009				
" 29	9:45 a. m.	E. C. I.				1004				
" 29	10:00 a. m.	R.				1001				
" 29	10:30 a. m.	Wch.				1025				
" 29	11:00 a. m.	Brg.				1002				
" 29	11:20 a. m.	Brg.				1009				Bot.
" 29	11:30 a. m.	S. S.				1016				
" 29	Noon.	Sl.				1016.5				
" 29	Noon.	Sl.				1016				Bot.
" 29	4:00 p. m.	E. C. I.				1006	80°	High		

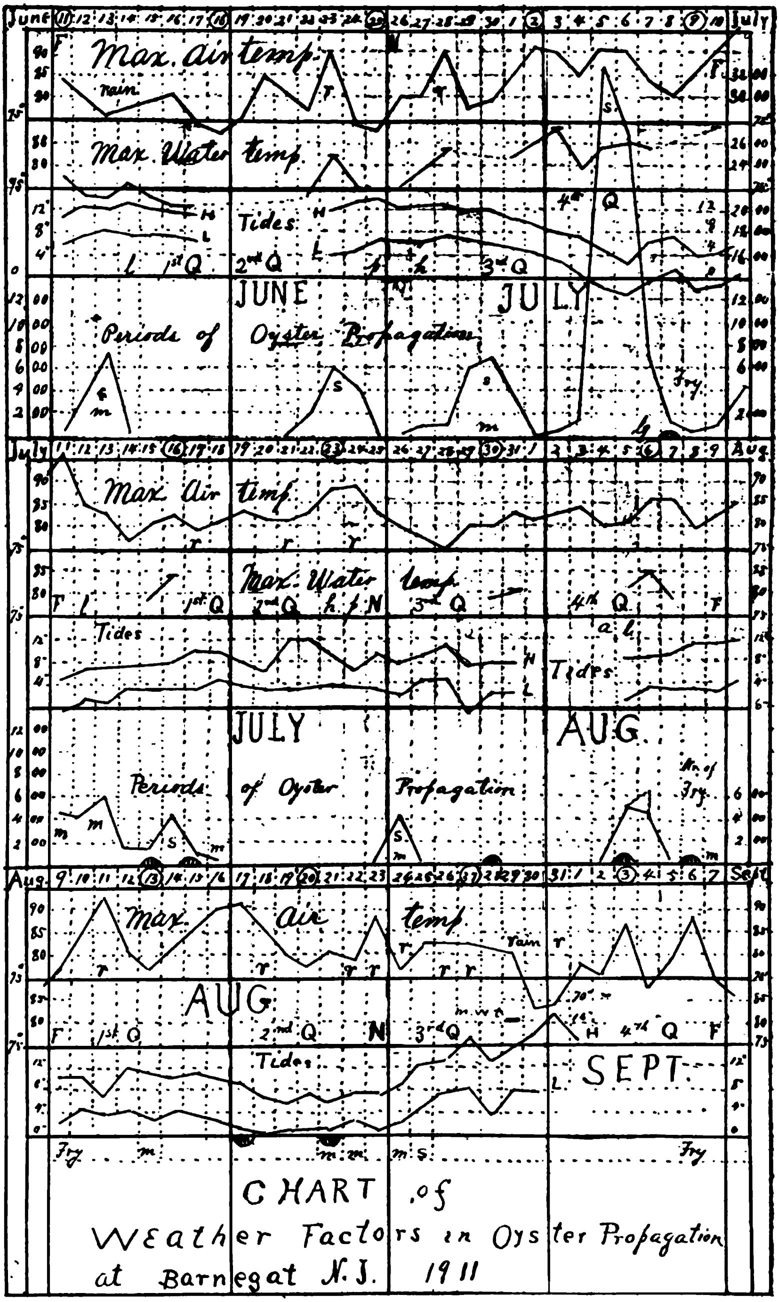

CHART of Weather Factors in Oyster Propagation at Barnegat N.J. 1911

EXPLANATION OF THE CHART AND TABLES, WITH GENERAL DISCUSSION OF CERTAIN DATA.

The chart is intended to show graphically the general results of a study of the data given in the tables. The chart is laid off, by means of vertical, dotted lines, so as to be thirty columns wide, each such space representing a day. Therefore, the chart will accommodate the record of a lunar month as nearly as practicable, in the width of the page. The record of three such months are shown under one another, each occupying a third of the page. The continuous vertical lines divide the month into four periods each of seven or eight days in length, corresponding with the changes of the moon. Full moon falls at the sides of the chart, and new moon close to the middle line for all three months. The lines between the completion of first and third quarters and the beginning of the second and fourth, lie near the middle of each half, as marked by the remaining two verticals.

The days of the month are entered at the top of each month, the Sundays being enclosed by circles. Directly below the dates is the curve of the maximum air temperatures, and below this is indicated the maximum water temperatures. Below this come the two curves representing the height of the high and low stages of the tide, respectively. Finally, on the lowest base line of each month is indicated the maximum number of fry found each day, on a scale of 1,600 to the inch.

The Temperature.

At the margins of the chart are indicated the values of the spaces that separate the horizontal lines. The curve of air temperature is referred to a base line marked 75 degrees Fahrenheit. The curve of maxima keeps well above this base, except near the beginning and the end of the season, in conformity with the excessively warm weather of the summer. The curve of maximal water temperature also indicates this fact. Reading only the highest parts of the waves shown, we see that on June 11th the water reached 77 degrees, unusually high so early in the season. June 23d the maximum was 82 degrees, July 3d it reached the highest point, 88 degrees, which was held until the cool wave of the 14th lowered the record to 84 degrees, and by the 31st it fell to 80 degrees. The hot weather of early August raised the maximum to 85 degrees by the 6th. On August 31st the cold waves had again lowered the temperature to 80 degrees.

But 80 degrees is the usual maximum for these waters, which this region especially favorable to a high temperature, attains. There is then no question as to the correctness of the conclusion that the phenomena of propagation were accompanied by a condition of high temperature beyond that to which the oysters had been habituated, or accustomed.

We have seen that the failure of spatting was a local phenomenon; it follows that the causes of the failure must likewise have been local. The unusually high temperature of the water was due, however, to climatic conditions that were general. On the other hand, this region is particularly easily influenced by changes in the weather. A very large proportion of the water areas here are so shallow as to be unnavigable. There are square miles of water scarcely a foot deep. The bay connects with the ocean by a small inlet, so the tidal interchange is very slight, averaging only an inch per hour. The effect of the great heat of the season was therefore unusually pronounced, so that it may fairly be considered a local factor.

By reference to the tables we see that during this season we also encountered water temperatures considerably lower than those plotted on the chart. We indicate some of the minimal temperatures as follows: June 16th we recorded 70 degrees; June 22d, 72 degrees; July 4th, 77 degrees; July 15th, 71 degrees; August 7th, 78 degrees. These temperatures are equal to the maxima generally attained on oyster beds in other regions. But we have to consider that the native oysters of Barnegat are as used to a subtropical climate as are those in southern waters, so that we have in any event to allow for this in our comparisons. There remains then simply the fact that these oysters were more than ordinarily, and more than were oysters of other regions, subjected to excessive heat conditions. We have shown that heat has in general a favorable influence on oyster reproduction. But we must admit that there can be too much of a good thing.

We may then fairly be justified in concluding that the unusual warmth of the water may be, if not the sole cause, then one of the chief causes of the failure of the set at Barnegat. Yet we do not know in what way this excess of warmth acted to produce the result.

Relation of Tidal Flow to Number of Fry.

The height of the tides has been indicated on the chart at the ratio of one to sixteen. The tides run highest in the week following the new moon, and lowest in the fourth quarter of the moon, when the neap tides occur. We see from the chart that the largest number of fry were noticed at the time of low tides, but we fail to detect any invariable relation between tides and spawning as we see so readily, between warm waves and spawning. This statement is not true as regards the relation of the *phases* of each tide within its own cycle.

We entered the various numbers of fry observed in the different samples of water, in columns representing the different phases of the tide that obtained at the time the samples were collected; on determination of the averages for the several columns we discovered a regular law as follows in their distribution:

At low water we made twenty-seven examinations, finding an average of 47 fry per bucketful. On the first of the flood tide we found in twelve samples 30 fry. On the middle of the flood, 13 samples averaged 170 fry. When the tide was near high water 30 samples averaged 217 fry. On high water 50 samples averaged 261 fry. Twenty-seven samples taken on the first part of the ebb tide averaged 393 fry. Eighteen samples of the middle of the ebb averaged 296 fry. When the ebb tide approached low water 35 samples averaged 63 fry.

We observe that the maxima and minima stand at opposite sides of the tidal cycle, and fall somewhat ahead of the maxima and minima of the tidal height. The curve is remarkably regular with the steeper slope on the ebb portion of the cycle.

How are these results to be explained? In general the most fry are to be found in the water at high, and least at the low phase of the tide. We must bear in mind that we are not dealing simply with a rise and fall of the water, but with currents that flow back and forth, and of which the fry are a part. The swimming powers of the fry are too feeble to change their distribution in the current directly. But they have the power to change this distribution indirectly. For they can rise and sink, they have the power to seek the bottom and to rise to the top. How far this power is exercised has still to be determined. But it is reasonable to suppose that it is exercised. Then the larvæ could control their own distribution.

There is another matter that enters into this calculation. We do not know on what phase of the tide the spawning is done, if tides influence this act at all. When spawned, eggs would probably sink to the bottom before being carried very far, unless the current is strong. After that the time of hatching has to be considered with reference to the tidal phase. We do not see how that could be regulated by such phases except that a falling tide would hasten hatching because it would be warmer. Hatching in any event occurs within the cycle of tidal flow during spawning. Then the fry can control their own distribution by rising on a flood tide, if they are to be carried up the estuary, or rising on the ebb if the reverse. Fry carried out to sea are lost, and it would not be advantageous for the fry to rise at the first of the ebb, unless they were located far up the stream. It follows that the distribution of the fry in a tidal current will depend on several factors, among which we mention, first, the distance of the oyster bed where the fry were produced from the point where the observation is made; second, the phase of the tide when the spawn was ejected; third, the habits of the fry in regulating their bathymetric distribution. So in the abstract it is a complex question on which it would be hazardous to venture a judgment until after further investigation. But as regards the phenomenon as observed at Barnegat, we venture a simple explanation, viz., that the spawn came from oysters far out in the bay, and so was not carried to the vicinity of the laboratory until near the close of the flood current.

Disappearance of the Fry.

The chart shows that there were special spawning periods at June 13th, June 23d and 30th, July 5th, 13th, 26th and August 5th. It is probable that the great lot of fry seen on July 5th was spawned on July 3d. In the wave recorded June 11th-14th there were many half grown fry, so there must have been a spawning period late in May. So there were at least eight periods of spawning during the summer. It must be understood that the spawning periods are not numbered simply by counting the waves of occurrence of fry that are shown in the chart; these are the result of a phenomenon which we have not as yet solved. The fact is that these fry appear and disappear in a manner strongly suggesting that they seek the bottom at certain times and rise to the surface at others. There are also probably other factors operative to explain this result. The spawning periods are ascertained solely by noting the proportion of newly hatched larvæ in the fry that are found day by day. But we have established the law that spawning does occur on warm waves of weather, under certain relations of those waves to each other. With so many spawning periods, and particularly in view of the great ejection of spawn early in July, when more than three thousand two hundred fry were counted in a bucketful of water taken in the open bay, and that at various places in the bay more than two thousand per bucket were found at the same time, it is most remarkable that so few attained the spatting stage of their development. The longer we ponder over this question the more mysterious it seems; we cannot at present answer this riddle. Even if we adopt the suggestion, or entertain the suspicion, or rest our judgment on the conclusion, that the one fact is to be explained by the other fact, that the water was too warm, how did this condition effect the result? Did the warmth act injuriously on the adults while the spawn was forming, did it stimulate spawning before the spawn was mature, or did it act on the larvæ; did it hasten the development too much; or did the cause act on the food of the adults, or on that of the larvæ? We must remember that the larvæ are themselves of the same size as the food eaten by the adults, so the larvæ must depend on very minute food. Did the warm weather favor the development of certain poisonous microbes that the larvæ ate, or did it directly or indirectly multiply the enemies of the fry? We must ever bear in mind that under most normal conditions there is an enormous destruction of fry, and hence we should expect that at Barnegat the climate in some way increased these inimical forces. But we do not at present know anything to boast of in respect to these normal destructive forces.

On the chart the letter "s" indicates small fry, "m" indicates medium fry and the black semicircles indicate the presence of large fry. It is evident that much remains to be done, and that the data which can be secured by the proposed oyster observation service, will be needed in solving the riddles of oyster propagation. Until these riddles are solved we can make but slight headway with practical applications for the benefit of the oyster industry. Already our discoveries have awakened widespread interest among oysterculturists.

REPORT OF THE BOTANICAL DEPARTMENT.

REPORT OF THE BOTANICAL DEPARTMENT.

BYRON D. HALSTED, Sc.D.
B. H. A. GROTH, Ph.D. EARLE J. OWEN, M.Sc.
MARY ROBINSON, Ph.B. MATHILDE GROTH.*

The work in the Botanical Department during the year 1911 has been under the same four projects as named in the last report: 1, Plant Heredity; 2, Plant Toxicology; 3, Plant Sap-Circulation; and 4, Plant Shading; to which has been added 5, Plant Environment. The lines of research with each project are quite specific. As an illustration, the studies under the last named are confined almost exclusively to that of the elongation of the seedling stem, the hypocotyl, as influenced by definite amounts of light, heat, moisture, depth of planting, mutilation, etc.

An acre and more of the experimental grounds was occupied with tomatoes upon which the second generation (F_2) plants of several types of crosses have been grown as a basis of continued research upon heredity. In like manner, eggplants and peppers were largely represented for the purpose of studying rules of descent of parental qualities in offspring of both crosses and hybrids.

Sweet corn was grown along with various kinds of the dent and flint types in thirteen widely separated blocks that further insight might be gained into the rules that govern inheritance in these plants.

A study of the "Garden Huckleberry" (*Solanum* sp.) has required much land-space that adequate material might be at hand for substantial results in its structural and other changes associated with definite ways of selection and culture.

The experiments with snap, lima and hybrid beans were continued, and a plot was devoted to the growth of okras, particularly a hybrid of the culinary with an ornamental species, the "Golden Bowl."

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*Began in September.

Several hundred plants of the common sunflower were grown as a second crop after the crossed peas, and also upon a portion of ground that had its squash plants killed by a nearby fire, and furnished a stock of sunflower seeds for a special line of research under the project of plant environment.

Aside from a severe drought that lasted from April 22d to June 1st, from which the eggplants suffered most, and the fire above mentioned, the experiment land yielded generally an average crop. Frosts held off until October 28th to 31st and permitted the peppers and okras, in particular, to make a fine autumn growth.

During the past year, the "Strips" and "North Acre" have been exchanged for two acres lying upon the north side of the "Home Grounds." This provides four acres in a single block and adjoining the office, tool and storage rooms and the greenhouse,—a very desirable union of land areas and their adjuncts.

One of the greenhouses, after seventeen years of service, has been replaced by a new modern structure that will add materially to the facilities for research, particularly during the winter season.

Two bulletins were published during the year, namely: No. 238, "The F_1 Heredity of Size, Shape and Number in Tomato Leaves," Part I., Seedlings (May 11th, 1911, 40 pages, 9 plates); and Part II., Mature Plants, of the same title (May 24th, 1911, 16 pages, 9 plates), both by Dr. Groth.

The routine work at the office desk has gradually diminished since the distribution of novelty cross-bred seeds was discontinued, thus giving more time for research.

EXPERIMENTS WITH CORN.

The work with corn during 1911 consisted largely in securing material for a study of immediate influence (xenia) in other factors than color and texture. To this end, field, pop and husk corns have been employed and the following notes, made at harvest time, just passed, cannot be more than general ones. There were fifteen blocks grown, so spaced in the field and planned as to time of blooming that the least possible promiscuous mixing might be secured. Enough material was obtained to absorb the attention for many months and crosses were secured that will furnish the

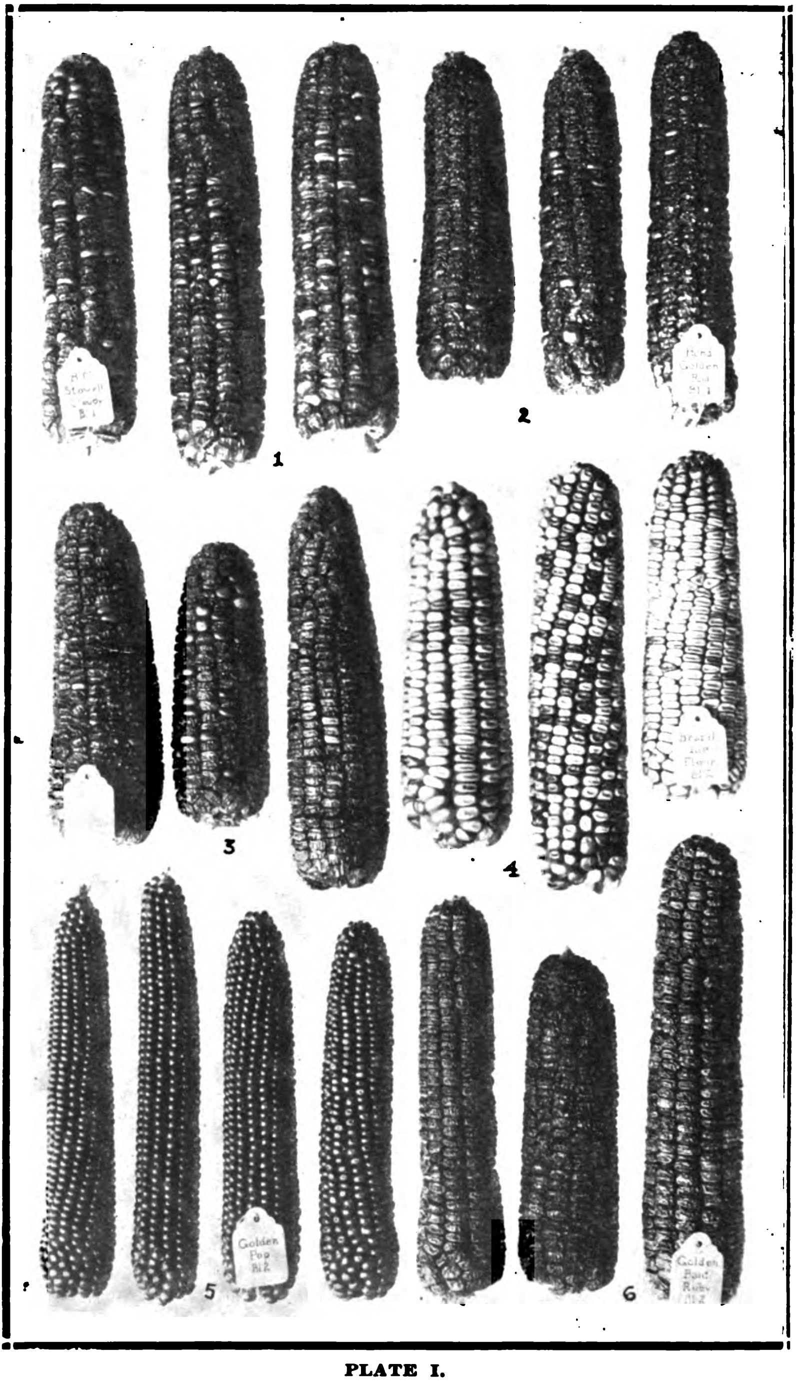

PLATE I.

Crossed Corn. Six lots of three ears each are shown, as follows: 1, "Black Mexican-Stowell" as crossed upon by various starchy types; 2, "Henderson's Golden Rod"; 3, "Voorhees-Stowell"; 4, "Brazilian Flour," showing results of crossing; 5, "Golden Queen Pop" corn; 6, "Golden Bantam-Ruby." While the crossing is very general with these ears, it is shown in but few cases in the engraving.

basis for future plantings. The report for the present will be upon the general results, block by block.

Corn Breeding. Block No. 1.

Rows 1, 4 and 7 were occupied with "Black Mexican-Stowell" F_3, tinted grains from crop of the same color in 1910, that is, the grains were neither black nor pink and showed the dark only slightly and in limited areas. The color of the pure sweet grains varied greatly, the prevailing one being a blue-black, with almost a total absence of pink. The black averaged much stronger than in the seed grains, but this varied greatly among the ears, some being nearly as black as the original "Black Mexican," while others showed only a trace of the dark color, thus indicating that color, even when of the endosperm, is largely a plant character. Three ears are shown at 1 in Plate I.*

The "New Century Wonder," rows 2 and 3—a large dent sort from Iowa—proved too late for breeding purposes, and the ears, borne six to eight feet from the ground, were quite green when the other rows were harvested.

"Hall's Gold Nugget," a very short, broad, yellow, starchy corn planted in rows 5 and 6, bred quite freely upon the "Mexican-Stowell," producing grains upon some ears with rounded tips and upon others with a decided dent, the latter looking much less yellow than the former.

The "Henderson's Golden Rod," rows 8 and 9, marked its yellow upon a large percentage of "Mexican-Stowell" grains, thus giving a peculiar appearance to the sweet kernels carrying both dark and yellow.

The "Hall's Gold Nugget" was not bred upon very freely by the "Mexican-Stowell" (the other sorts not being shown), some ears not at all, while others showed nearly twenty per cent. of the grains of a color ranging from a mixture of dark and yellow to those in which the "Mexican" "blood" showed only a trace of dark mottling. It remains to be shown whether the crossed grains have any difference in size, texture, specific gravity, etc., from the pure "Nugget" kernels.

The "Henderson's Golden Rod," rows 8 and 9, proved to be a fair sized yellow sweet corn that was bred upon but little by the "Mexican-Stowell," the crossed grains of course showing a mixture of dark and yellow. There were likewise only a few of the starchy grains due to the crossing with the "Gold Nugget." Nothing probably came from the "New Century" because of its lateness, or from the "Malamo" as it is a very early sort. Three ears are shown at 2 in Plate I.

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*The plates in this report were made from photographs by Mr. F. H. Dodge, to whom many thanks are due for his courtesies and painstaking skill.

The "Malamo" occupied a single side row and was planted with fifty grains from an ear that had been grown alongside of true sweet "Malamo." Of forty ears produced, thirty-five were classed as flinty and five were nearly pure sweet. The most flinty ears showed only an occasional grain that was more or less wrinkled; other ears had a half of the grains wrinkled, and so on by degrees to the normal sweet ears.

Corn Breeding. Block No. 2.

Rows 1, 4 and 7 grew "Voorhees-Stowell" F_3, selected pink grains from a single ear of the crop of 1910. There were sixteen good ears of solid pink and thirty-four containing more or less white grains. Nearly all the ears contained a few dark grains, but the general effect of color of the ears as a whole was a rich pink, like that of the mother kernels. The "Brazilian Flour" crossed only to a small extent upon the "Voorhees-Stowell" and very uniformly produced dark gray kernels, easily distinguished among the pink grains. Only an occasional grain of the cross with the "Golden Queen" appeared, and when the grain carried pink, the flinty kernel had a handsome amber or "wine" color, while those without the pink were, of course, yellow but of a lighter (lemon) shade than in the "Golden Queen." Three ears are shown at 3 in Plate I.

"Brazilian Flour" occupied rows 2 and 3, and this white, starchy field variety, that varied from nearly pure flint to ordinary dent, was crossed upon quite freely by the "Voorhees-Stowell," as shown by the color which, while generally black to gray (or "lead"), depending upon the ears, showed signs of pink in one ear of a deeply dented type, but the general tendency was for the pink mother grains to produce upon the white "Brazilian" a color much darker than their own. There was but little crossing of the "Golden Queen" upon the "Flour," and in all instances the orange of the parent was diluted to a lemon color. Three ears are shown at 4 in Plate I.

Rows 5 and 6, planted with "Golden Queen" gave a good yield of fine ears of this attractive popcorn, nearly all of which showed grains that were crossed with the "Voorhees-Stowell." These grains ranged from almost black to a pale amber. Of course, there was a blending of the colors of the two parents, and it is likely that the yellow of the mother plants masked entirely the pink of the pollinator. A few of the "Queen" mother grains carried white as recessive, and the ears from these showed a small percentage of white grains, and some of these kernels were a delicate rose color, showing that the presence of yellow modifies the color very materially, that is, side by side the grains are white, rose, orange and amber with varying degrees of darkness. Any crossing of the "Brazilian Flour" and "Golden Queen" was not distinguishable in the yellow grains of the mother sort. Four ears are shown at 5 in Plate I.

The "Golden Bantam-Ruby" cross occupied rows 8 and 9, and upon this the "Voorhees-Stowell" bred in only small quantity. Some ears showed only dark grains, others chiefly pink, while a few bore a wide range of colors. There was a general absence of white, starchy grains from the "Flour" and yellow ones from the "Queen." The "Ruby" "blood" (the color of the pulp of a "blood" orange) was seen in the grains of a few ears, while others showed it in the dark red of the chaff and the cob. Three ears are shown at 6 in Plate I.

"Malamo" from amber sweet grains, grown near flinty plants, occupied row 10. The crop was small because of the drought, there being only twenty-six ears, as follows: Full amber, 10; partial amber, 7; ordinary white, 9. There were no flinty ears and, owing to the earliness of the variety, crossing with flinty or dark sorts was not in evidence. The white flint ("Brazilian Flour"), when crossed upon this lot of "Malamo," gave grains partaking of the ear color, amber, etc.

Corn Breeding. Block No. 3.

"Indian Squaw," a black corn of the field type with the endosperm soft or floury, occupied rows 1, 4 and 7. The yield was good, the ears being large and cylindrical, occasionally red-cobbed with ten to twelve rows of large grains, but little inclined to dent, and having the dark purplish color located close below the pericarp and not spread through the white floury endosperm. Some of the ears grown showed a few pure chalky white grains and several had many kernels with a dirty yellow shade, an indication of the "Gold Nugget" having been the pollinator. Two ears are shown at 1 in Plate II.

Rows 2 and 3 grew the "Black Mexican," and upon it the "Squaw" bred freely, some of the ears being more than half with smooth grains, the texture of which is a subject for further study. The color of the grains was not materially changed; however, the smooth ones showed more of the peculiar purple that is seen in the pure "Squaw," but how much of this is due to the smooth surface is not determined. There was a single grain of chalky white upon one ear; otherwise all ears were solid black.

The "Late Mammoth" occupied rows 5 and 6, and produced its usual crop of very large ears, shown at 2 in Plate II, all of which were crossed upon by the "Squaw," producing smooth grains of a pale lilac color, often mottled, while some were solid "lead" or gray. There was a less number of the "Mexican" crosses, as shown by the wrinkled grains bearing dark or lilac color quite comparable with the shades and tints produced by the "Squaw." The "Gold Nugget" came out in only a few of the grains, and here the color was a pale yellow instead of the golden hue of the pollinator. The grains were frequently shorter than the surrounding sweet kernels.

"Hall's Gold Nugget" filled rows 8 and 9, and the long eight-rowed ears at 3 in Plate II, showed a small percentage of dark grains, all flinty among the golden ones. To the superficial eye there was no difference between those that might have come from the "Squaw" and from the "Mexican."

Row 10 was planted with "Adams-Crosby" F_2, flinty grains, and being an early sort was injured by the drought, the yield of marketable ears being only twenty-one, showing all degrees of flintiness but grouped in a general way into thirteen that were flinty and eight with quite sweet grains. Both the "Squaw" and the "Mexican" produced many dark grains, and upon the most flinty of the ears it was not certain in all instances which dark parent was represented. The "Gold Nugget" crossed grains showed as flint grains upon some ears and dent upon others, indi-

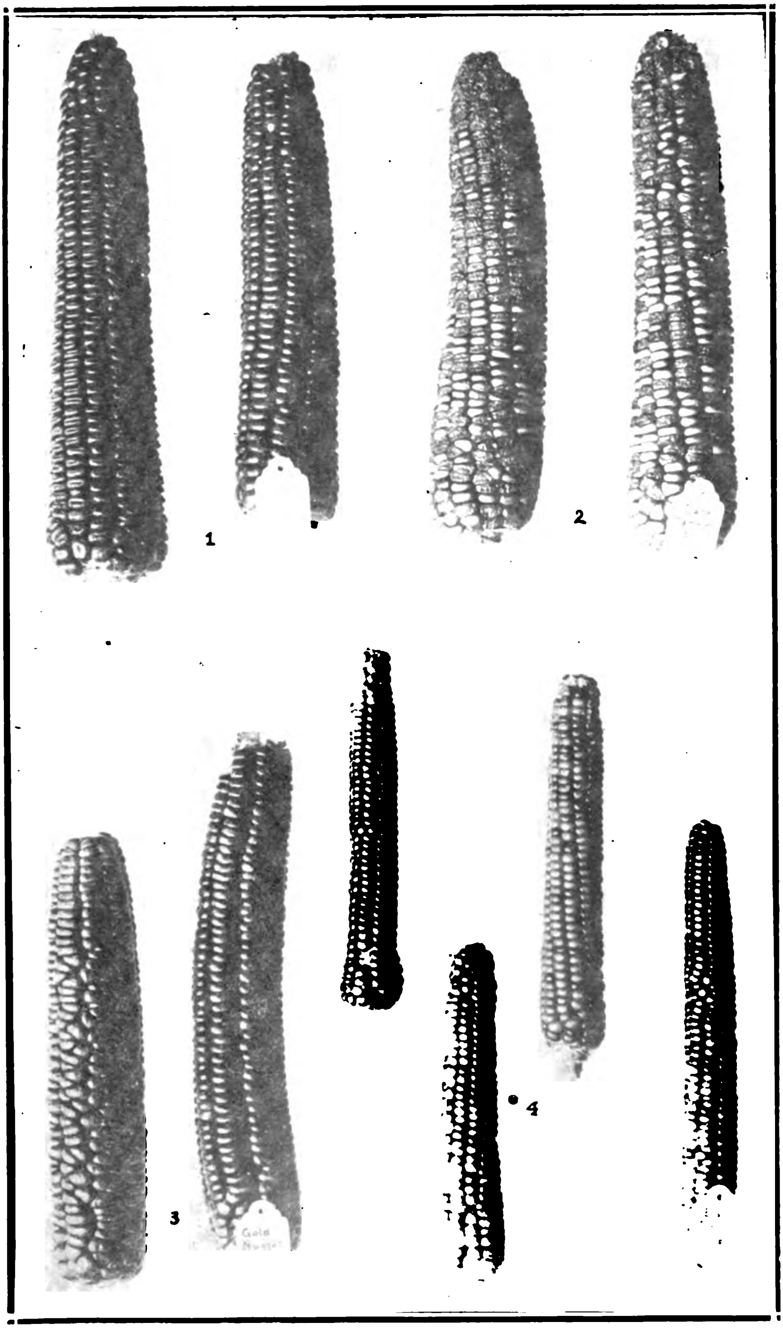

PLATE II.

Crossed Corn. Four lots of corn, namely: 1, "Indian Squaw"; 2, "Late Mammoth"; and 3, "Gold Nugget," two ears each; and 4, "Eight-Rowed Pop," four ears, all much involved in the crossing work of the season.

cating that the dent factor of the "Adams" parent of the cross of "Adams-Crosby" held sway and is a plant (or ear) character clearly brought to light by breeding in of a starchy variety.

Corn Breeding. Block No. 4.

Rows 1, 4 and 7 gave a fair crop of "Eight-Rowed Pop." Upon this white sort the chief breeding was the "Voorhees-Golden Bantam-Banana," represented in the planted seed by selected pink grains. In no instance was the distinct pink of the parent seed reproduced in the crossed grains, but instead the color ranged from almost coal black, in a few instances, through many shades of gray (slate) to kernels that showed only a trace of the slate and this frequently in patches ("clouded"). The crossed grains upon the same ear were generally alike, that is, the character of the coloration was more or less a plant factor, and in case of twins both ears agreed in the shade of the dark grains.

The "Eight-Rowed Pop" crossed very readily with the "Voorhees," as shown by the large number of the dark kernels, sometimes much more than a half. This gave abundant material for the study of relative size and weight of the crossed and non-crossed grains. Four ears are shown at 4 in Plate II.

The "Voorhees-Golden Bantam-Banana" seed, as before stated, was of a light pink selection from a similar crop of the previous year. Upon either side of its two rows was grown the "Eight-Rowed Pop," and the mixing in of the latter was quite general, the amount ranging among the pink ears of from 1 to 40 per cent. Three ears are shown at 1 in Plate III.

About a half of the ears showed the absence of any recessive white grains (the yellow of the cross having been eliminated previously), and were solid pink with the exception of the flinty grains that were due to the crossing with the "Eight-Rowed Pop" close at hand, and these were uniformly of a gray or "lead" color and easily detected in this way before the sweet grains, with which they were mixed, had become wrinkled.

In the previous notes it was written that the pink pollen plant produced dark, sometimes almost black, grains upon a white flint ear. Here the reciprocal of the two parents is represented, and the ears that, under isolation, would have yielded sweet pink grains, now have a percentage of flinty grains that show, instead of the pink of the mother, a gray approaching that of the reciprocal. The color may be the same in all, but the great difference of texture accounts for the results noted.

"Crosby" occupied rows 5 and 6, and upon this the "Eight-Rowed Pop" bred freely, many of the ears having fully two-thirds of the grains flinty white. The flinty grains upon any single ear were generally alike as to the exposed end; that is, some had the kernels smooth, rounded, and showing no white due to the starchy region of the interior coming close to the surface, while other ears had the grains grooved at the tip (dent) and strongly white, due to the thin corneous layer. Three ears are shown at 2 in Plate III. Only a few ears showed the cross with the "Voorhees." Here the range of color was from dark slate to the lightest pink upon some of the ears; while others showed only the slaty grains, suggesting that the mother plant has an influence upon the color. Only the younger ears showed the "Voorhees" mixing due to the fact that the "Crosby" is an earlier sort than the last named. One cannot judge of varietal susceptibility when the several sorts in question in a block do not bloom at the same time. This fact is shown by the almost total absence of yellow grains upon the "Eight-Rowed Pop," "Voorhees" and "Crosby"; while the "Golden Pop," a dwarf sort, occupied rows 8 and 9 of the block, but was so early in bloom as to be of no value in crossing with them.

Corn Breeding. Block No. 5.

Rows 1, 4, 7 and 10 were occupied with "Golden Bantam," and its breeding with the "Red Glaze" was apparent from the presence of flinty grains among the wrinkled ones. The red of the flint parent is lost from view, and only the yellow, which is common to the endosperm of both parents, appears. The yellow color is much lighter in some ears than in others, due to the relative amounts of the starchy and corneous substances at the outer end of the kernel, it being light yellow when the latter is thin and darker when thicker. The "Voorhees" crossed more abundantly in the later and smaller ears and the kernels were quite uniformly dark like the pollen parent seed. Upon the same ear there was sometimes a difference in the amount of wrinkling, that is, in the same row, and side by side were dark grains that were not equally

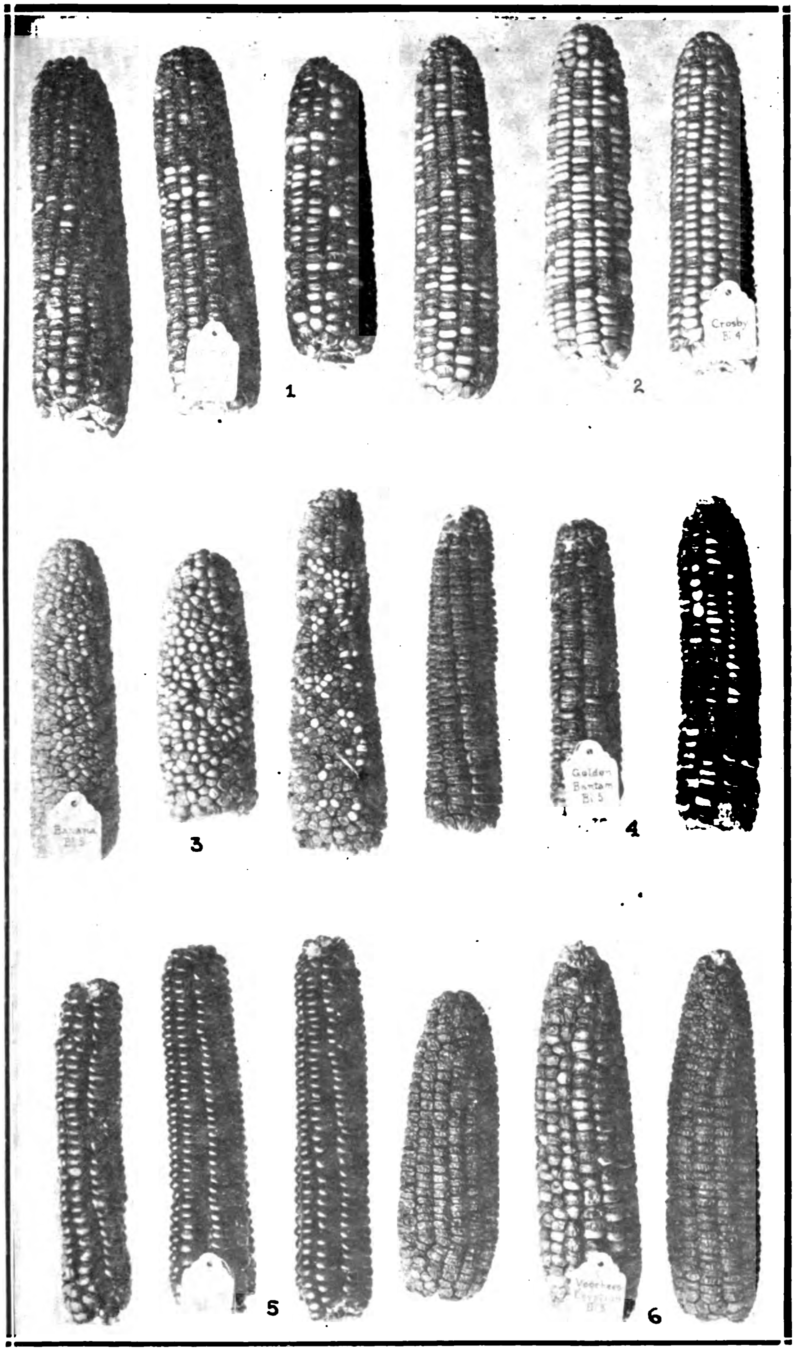

PLATE III.

Crossed Corn. **Six lots of three ears each are shown, as follows: 1, "Voorhees-Golden Bantam-Banana"; 2, "Crosby"; 3, "Banana"; 4, "Golden Bantam"; 5, "Red Glaze"; and 6, "Voorhees-Egyptian." In some of these samples the crossing is still evident but much of the clearness is lost.**

wrinkled. Rows 2 and 3, occupied with "Banana," bore a good crop of this zigzag variety of sweet corn upon which the chief crossing was the "Voorhees-Egyptian." A dark strain of the latter that showed flintiness was used, and crossed grains upon the 'Banana" ears were generally darker, that is, not distinctly pink and varied greatly, some of them being only cloudy or mottled gray. It remains to be shown whether these grains were the same in size and weight as their wrinkled neighbors. Three ears are shown at 3 in Plate III. The next cross in point of number was the flint of the "Red Glaze," the grains of which have the pericarp of a dull orange-red and a pale yellow corneous layer beneath. The flinty grains upon the "Banana" ears vary greatly in the amount of yellow, many of them being easily counted white. When green, these crossed grains are not distinguishable from their sweet neighbors, but when mature and dry, of course, the size and weight are different.

The season of the "Golden Bantam" is earlier than the "Banana," and only the later ears of the second showed many yellow wrinkled grains. That they are any earlier in reaching maturity seems doubtful as judged from the appearance of the ripening ears as they were husked. Three ears are shown at 4 in Plate III.

"Early Glaze," a flint corn previously described, was grown in rows 5 and 6. The long, slender, eight-rowed ears showed but a comparatively few grains that were marked with the "Voorhees-Egyptian," and these were quite variable, first among the ears and secondly among the grains of the same ear. The ears, as to the color of the glazed grains, were quite unlike, some being light yellow and others orange-red, due apparently to the thickness of the corneous layer bearing the yellow; when this was thin, the white of the starchy interior appeared through the cover. Upon the latter ears, in the crossed grains, the dark color was more or less in streaks radiating from the free end of the grain. In the dark orange-red ears the crossed grains approached a uniform black or dark brown. It remains to be seen whether these crossed grains are of the same size, texture and weight as their neighbors. Three ears are shown at 5 in Plate III.

"Voorhees-Egyptian," selected flinty grains, was grown in rows 8 and 9, and gave a large yield of very dark, almost black, ears, when the grains were fully dried. Flintiness showed itself generally as exhibited in the middle ear of the three from this lot at 6 in Plate III.

Corn Breeding. Block No. 6.

This block was badly scorched by fire and the crop much shortened thereby.

Rows 1, 4 and 7 were occupied with "Iowa Silver Mine-Stowell," and produced a few of the characteristically large ears upon which the "Voorhees"-cross bred freely, as shown by the grains that ranged from nearly black to pink. There were a few white flint grains from the "Aztec," and a considerably larger number of yellow flint from the "Yellow Dent." Two ears are shown at 1 in Plate IV.

The "Early Aztec," a white dent, in rows 2 and 3, gave only thirteen good ears, and upon some of these the "Voorhees"-cross showed several purplish grains. There was only an occasional grain made yellow by the "Reid's Dent."

Rows 5 and 6 were occupied with "Reid's Yellow Dent," and with this the "Voorhees" crossed quite freely. The presence of yellow and dark colors produced an unusual mixture of shades and tints. Two ears are shown at 2 in Plate IV.

The "Voorhees-Golden Bantam-Banana" cross was in rows 8 and 9, and the twenty-nine ears of marketable size were: Solid red, twenty-three, and with white, seven. All were crossed upon by the "Aztec," showing lead color upon red ears and plain white upon white grains. The "Yellow Dent" produced grains of dull brown, but without the dent quality.

Corn Breeding. Block No. 7.

This block consisted of 510 hills located at a corner of a piece of land a hundred rods or more from the blocks previously described.

There were fifteen sorts, two rows each, of white sweet corn selected as a basis upon which five other kinds were arranged for breeding, as follows:

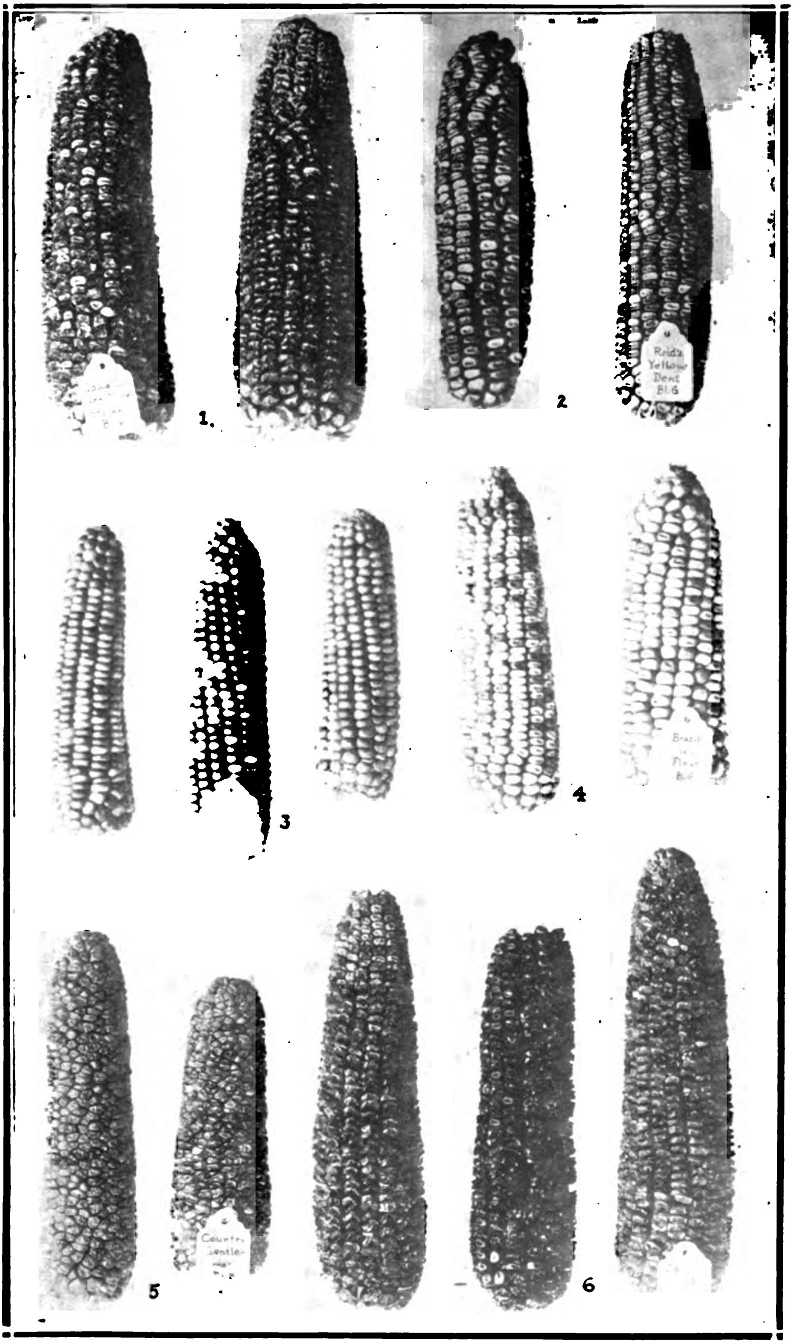

PLATE IV.

Crossed Corn. Six lots of ears are shown, as follows: 1, "Iowa Silver Mine-Stowell"; 2, "Reid's Yellow Dent"; 3, "Field Dent-Yellow Dwarf Pop"; 4, "Brazilian Flour"; 5, "Country Gentleman"; and 6, "Calico-Country-Gentleman."

1. "Broad Grained"	a a × a a × a a × a a × a a × a a
2. "Banana"	b b × b b × b b × b b × b b × b b
3. "Cosmopolitan"	c c × c c × c c × c c × c c × c c
4. "Country Gentleman"	d d × d d × d d × d d × d d × d d
5 "Crosby"	e e × e e × e e × e e × e e × e e
6. "Early Mammoth"	f f × f f × f f × f f × f f × f f
7. "Farquhar's First Crop"	g g × g g × g g × g g × g g × g g
8. "Howell's Evergreen"	h h × h h × h h × h h × h h × h h
9. "Late Mammoth"	i i × i i × i i × i i × i i × i i
10 "Oregon Evergreen"	j j × j j × j j × j j × j j × j j
11. "Potter's Excelsior"	k k × k k × k k × k k × k k × k k
12. "Mexican-Stowell" (white)	l l × l l × l l × l l × l l × l l
13 "Pride-Stowell" (white)	m m × m m × m m × m m × m m × m m
14. "I. Silver Mine-Country Gentleman" (zigzag)	n n × n n × n n × n n × n n × n n
15. "Iowa Silver Mine" (red cob)	o o × o o × o o × o o × o o × o o

The five breeders that occupied the rows respectively that are marked with the cross were: (1) "Red Rice Pop," (2) "Indian Squaw," (3) "Aztec," (4) "Henderson's Golden Rod," and (5) "Black Mexican."

At this early date little more has been done with the crop than to place selected ears of each of the sweet sorts for careful drying. It is, however, stated that all five of the breeds are abundantly represented as a whole upon the white sweet varieties, but the amount is very variable, due in large part to the times when the kinds were in bloom.

The short distance in which the pollen generally passes was abundantly illustrated, for, as a rule, the great majority of the crossing was done upon the adjoining rows and but very little at the distance of ten or more rows.

The sweet ears carried white starchy from the "Red Rice," black starchy from the "Squaw," yellow starchy from the "Aztec," black sugary from the "Black Mexican," and yellow sugary from the "Golden Rod."

Corn Breeding. Block No. 8.

Row 1 was occupied with "Squaw," and its large cylindrical ears did not differ from those produced upon the blocks previously considered.

The "Dent-Pop" cross, selected yellow grains, was grown in row 2, and the ears were quite variable, some of them resembling the "Yellow Pop" parent, while others strongly favored the "White Dent," but were very much smaller. Dark grains were numerous, due to the "Squaw" and "Black Mexican" in the same block. It is likely that the two parents may be separated upon (1) the basis of color, as many grains have a blue-black, suggesting the "Squaw"; or (2) by the texture of the grains. Three ears are shown at 3 in Plate IV.

"Brazilian Flour" occupied row 3, and the ears of this white dent contained many black grains, some of which may have come from the "Squaw" and others from the "Black Mexican," as in the last case. Two ears are shown at 4 in Plate IV.

The "Black Mexican," row 4, showed many flinty grains, some dent, others smooth, possibly depending upon the source of the starchy quality.

Row 5, occupied with "Henderson's Golden Rod," showed a large percentage of dark sweet grains, that is, a mixture of its yellow with the black of the "Mexican," besides a number of flinty blue-black grains from the "Squaw" and some yellow flint from the "Dent-Pop" cross. The lot of ears was quite indescribably mixed, and the ground work of yellow of the mother added much to the unusual appearance.

"Country Gentleman" was grown in row 6, and produced a lot of quite evenly mixed ears, showing the "Squaw" as lilac flinty grains, and the "Black Mexican" as much darker and, of course, wrinkled kernels, while the "Brazilian" marked a few grains as white flint, and the "Henderson" produced a large number of yellow sweet grains. Two ears are shown at 5 in Plate IV.

Corn Breeding. Block No. 9.

Row 1 produced a fair crop of "Black Mexican" from seed selected for flintiness, and the ears showed much of this undesirable quality.

"Golden Bantam" was grown (row 2) for its yellow color, and proved too early for "marking" itself upon the later sorts in the block.

Row 3 carried the cross of "Calico" upon the "Iowa Silver Mine-Country Gentleman" cross selected for sweet white grains, and there resulted very large fine-shaped ears that bore many grains showing the crossing upon it of the "Mexican" and "Gold Nugget." Three ears are shown at 6 in Plate IV.

Corn Breeding. Block No. 10.

Rows 1 and 2 were planted with "Country Gentleman" and were crossed upon liberally by the "Squaw," close beside it, and the flinty grains had a peculiar "lead" color that is a dilution of the blue-black of the pollen parent. There was only an occasional flinty yellow grain from the "Husk," or sweet yellow from the "Golden Rod."

The "Squaw," row 3, produced one ear with a quarter or more of the grains wrinkled and of the blue-black of the "Squaw," indicating that the mother grain was a mixture with some sweet sort.

The "Late Mammoth," occupying rows 4 and 5, showed much crossing upon it of the "Squaw," but here there was a decided pink color to many of the grains, others being "lead," and many mottled. There were but few yellow flint grains, and none of the yellow sweet type.

"Husk" corn grew in row 6, and yielded poorly, there being only eight good-sized "husk" ears, while ten had no husks, were very variable in many details, and not to be distinguished from common starchy corns, some dent, others flint, and all, with one exception, a mixture of yellow and white. The "Squaw" crossed upon this sort but slightly and gave a decided blue color.

Rows 7 and 8 carried the "Oregon Evergreen," and gave only a light yield, but was crossed upon by the "Squaw," "Husk," "Golden Rod," and some sweet black grains came from the "Mexican" grown in the adjoining row 9.

Rows 10 and 11 were planted to selected white grains of "Mexican-Stowell," and bore many dark grains that are evidently crosses with the "Mexican" parent, while some ears produced many very pale pink grains, suggesting that the mother grains were not fully free from color, as, for example, an ear quite generally pale rose pink bore scattered black grains.

The "Henderson's Golden Rod" did poorly, and the few ears showed but little crossing, chiefly with the "Mexican."

The cross of "Golden Bantam-Ruby," grown in rows 13 and 14, was likewise a small crop with only twenty-two marketable ears, fourteen of which showed the "Ruby" cob, the amount of purple varying greatly, and eight were with white cobs. There was but little crossing upon this variety.

Corn Breeding. Block No. 11.

"Adams-Crosby" occupied rows 1 and 2, and the closely set ears, a characteristic of this desirable cross, contained a large number of dark grains, due to the "Mexican" in the adjoining row. There was none of the flintiness of the latter being transmitted at once, but several of the "Adams-Crosby" ears showed flintiness throughout and upon such the dark grains were of the same texture as the white kernels. Some of the ears had the "Mexican" grains uniformly of a mottled dark, indicating that the intensity of the color is governed by the mother plant. There was very little of crossing of the "Shenandoah" (yellow) or "Pop" (white) upon this early sort. "Black Mexican," in row 2, bore some ears entirely free from crossed grains with flint sorts, while others showed many such kernels. Two ears bore each a single white wrinkled grain, and one ear, larger and later than the others, had dent flinty grains, many of which were from the "Shenandoah."

The "True Early Crosby" occupied rows 4 and 5 and crossed freely with the "Mexican" with some loss of color but rarely any tendency to the pink hue. Only a little crossing of the "Shenandoah" was in evidence.

The "Shenandoah Special" of row 6 gave a few ears showing more than twenty-five grains that had the dark color due to the "Mexican," and those on account of the yellow of the mother were quite tan colored.

"Golden Bantam-Country Gentleman," in rows 7 and 8, was crossed upon but little by the "Mexican," the grains being quite uniformly black, and by the "Shenandoah" and the "Pop."

The "Dent-Pop," selected white, row 9, yielded a variable set of ears; four were dent, like the male parent, and eleven had smooth grains, with one intermediate. In cob color, eight were white and seven rusty; these latter, as a whole, resembling the dent more than the white cob group. All of the smaller ears with shape of grains resembling the "Pop" were with white cob.

"Early Mammoth" made a good crop in rows 10 and 11, but was crossed upon but slightly excepting by the "Golden Bantam." Next to the yellow sweet grains in number were the white from the neighboring "Pop."

The "Golden Bantam," row 12, probably exchanged freely with the "Mammoth," but there was little else in the way of crossing.

"White Malakhof," in rows 13 and 14, was grown for a special test and matured too early for crossing, only an occasional yellow sweet grain from the "Golden Bantam" being present.

Corn Breeding. Block No. 12.

Rows 1 and 2 bore "Late Mammoth" upon which the "Striped Pop," row 3, bred freely, producing white grains that upon some ears were of the true flint type, while others showed a well developed dent indicating that the factor for dent was carried by the sweet variety that ordinarily never shows it.

Rows 4 and 5 carried the "Jersey Sweet" ("Iowa Silver Mine" upon "Country Gentleman"), and the large ears were much marked with the "Squaw," row 9, as lilac starchy grains, and "Voorhees-Egyptian," selected black, row 12, gave a few pink sweet grains.

The "Pride of the North," a yellow field dent, row 6, bred with its neighbor, "Livingston's Broad Grained," rows 7 and 8, as did the "Squaw" and "Voorhees," producing greatly variegated ears of this unusual type of sweet corn.

Corn Breeding. Block No. 13.

One of the leading features of this block was the attempt to breed the so-called "Cobless" corn (row 4), upon the "Adams-Crosby" (rows 1 and 10), the "Squaw" (row 2), the "Pride-Stowell" (row 3), "Silver Mine-Country Gentleman" (row 5), "Mexican-Stowell" (row 6), "Silver Mine-Stowell" (row 7), the "Golden Rod" (row 8), and the "Late Mammoth" (row 9). This breeder is a flint corn, mixed yellow and white and produced a row of tall plants, some few of which were entirely without ears and developed a tassel of unusual character that soon became bowed with its weight of grain. At 1 (Plate V) is shown one of these tassels in its drooping position, the branches of which are loaded with nearly spherical grains, quite indistinctly shown among the bracts. The major portion of the plants in the row, however, had side branches (ears), and their tassels were of the ordinary sort.

The true ears, with husks, etc., varied greatly in size and shape, some being very short, nearly as broad as long; while others were even more slender than corn ears generally, as illustrated at 2 and 8, respectively. Again, the huskiness was subject to great variation, for in some ears the grains were encased in husks that were four centimeters long, as shown at 3 and 4; while others had the husks so short that the grains were partly in sight, as seen at 6, 7 and 8. As a rule, the husks were longer near the butt end of the ear, as is well shown in the very long slender ear at 8, with its weather-stained tip due to its ear-husks not being long enough to cover it, a condition that obtained in several cases. At 9 is shown an ear from the same lot of seed in which the tendency to produce a tassel is seen at the tip, while at 10 a normal ear from cobless seed is photographed. In short, in this lot of seed with parentage unknown to the writer, there resulted all gradations between the earless stalk with large seed-bearing tassel, through various degrees of husk development to an ear of the ordinary sort. Some crossing with sweet corn had taken place.

Corn Breeding. Blocks Nos. 14 and 15.

These two blocks, the last of the series for 1911, were badly damaged by the fire that, upon July 11th, destroyed the neighboring College Farm barns and other buildings. Block 15 was so close to the flames as to be entirely destroyed, while from Block 14 only a fraction of a crop was obtained.

A Study of the "Dent-Pop" Crosses.

Row 2, block 8, bore the third generation of "Field Dent" (white) upon "Dwarf Pop" (yellow), and was grown from a single ear, six inches long and bearing twelve rows of flint grains. This

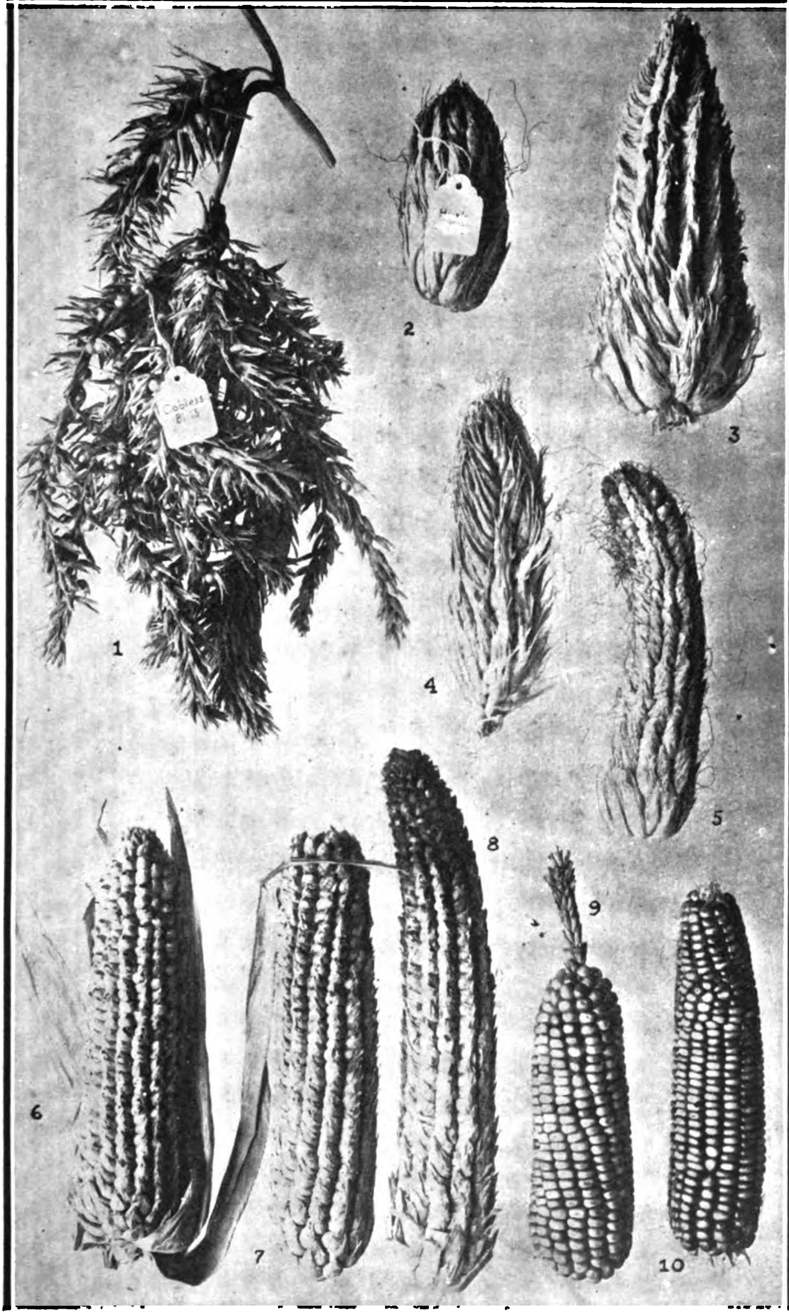

PLATE V.

Crossed Corn. The "Cobless" corn is shown in several of its phases of development. At 1 is the true type, a tassel filled with grains. From 2 to 10 are shown different degrees of development of the husk grains, some ears having their husks very long and others with theirs entirely absent.

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mother ear was an average of the variable lot, and only the light yellow kernels were selected. The twenty-three marketable ears harvested made a series ranging from a fourteen-rowed ear of dent grains to one two inches long that might easily pass as a pure pop. In other words, there was no suggestion of a separation into two distinct types of ears like the parents or an average of the two. Sometimes a large ear had the small grains of the "Pop," while others had large kernels upon small cobs. All had white cobs.

Row 4, Block 14, was planted with the "White Dent-Pop," third generation, orange grains. The orange color was predominant in the crop, and all of the twenty ears showed white grains. The mother ear was seven inches long and the grains were slightly dented in some instances. Some of the offspring were dent ears, like the original parent, but in every way smaller and usually more taper-pointed at the tip. There was a much closer approximation to the "Field Dent" than to the "Yellow Pop" parent.

Row 9, Block 11, was planted with the white grains of the "Dent-Pop" cross, third generation, the mother ear being a slender one, five inches long with sixteen rows of small kernels upon a white cob. Here again there was a series of ears from the coarse dent field type to the small flint of the mother "Pop." There was a lack of uniform correlation, however, between the size of ear and grain. There was not a single ear that closely resembled the one from which the mother grains were taken for planting, leaving little to hope in this instance of the immediate establishment of a type of ear and grain. In cob color, eight were white and seven rusty, these latter resembling the "Dent" parent more than the white cob group.

Color in "Indian Squaw" Crosses.

The "Indian Squaw" corn is a coarse field variety with the large ears bearing broad and thick kernels more or less dented and having the endosperm abounding in a white powdery material, thus giving it the name of "flour" corn. The color of the exposed end of the grains as situated upon the cob varies somewhat among the ears, but in general ranges from a blue violet to a combination of red and violet—4BBV, 5BV and 4RV2 being some of the combined shades and tints, as expressed in Prang's "Standard of Color."

The "Squaw" has been bred upon a large number of corns, and from the results obtained the following general statements are drawn. Upon the "Black Mexican," the color is quite uniform among the grains upon any one ear, but in different ears there is a considerable range of blues, reds and violets, and aside from being starchy, such crossed grains are generally distinguished by their color from the "Black Mexican." In the "Late Mammoth" the "Squaw" cross is remarkable for the great reduction of the amount of the color, the dilution being along the line of pale blue and lilac, and these colors are frequently irregularly disposed, thus giving a mottled "calico" or clouded grain, as the case may be.

The "Gold Nugget" grains, bearing the "Squaw" impress, had generally a green shade, apparently due to the mingling of the blue and yellow. The amount of color varied greatly, as previously noted, and it seems probable that many grains carry the blue of the "Squaw" without showing it.

The "Adams-Crosby" crossed upon by the "Squaw" gave practically the same result as with the "Late Mammoth" above stated; that is, the color had a "washed out" appearance when compared with that of the pure "Squaw."

The "Dent-Pop" cross was exposed in Block 8 to both the "Squaw" and the "Black Mexican," and, while there was a great range of variation in the dark grains, the intergrading from the very dark to the cloudy grains forestalled any decision with the eye between those resulting from one and the other dark pollinator. The "Brazilian Flour," as a white dent, crossed freely with the "Squaw," and here again the intensity of the dark color is shown to be largely an ear character, but in general the color was pale blue extending into the violet and becoming very obscure in some kernels.

In the "Henderson's Golden Rod" was an opportunity for discerning differences in color values between the "Squaw" and the "Black Mexican" because the former added the starchy character to the grains. Such grains showed a decided blue in its various shades and tints with violet that obtained but little in the dark sweet grains. It remains to be shown how much influence the wrinkling of the grain may have upon the visual appearance of the color. The crossing upon the "Country Gentleman" illustrated in a striking manner the plant control, for in some ears the "Squaw" produced violet grains generally, while others showed a strong blue color and still others a shade that approached "lead," a color that in corn is associated with immature grains, but in this case the kernels were ripe. Here again the "Black Mexican" was associated with the "Squaw," and a similar plant control was evident; that is, the ears yielding violet "Squaw" cross produced a pinkish "Black Mexican" cross. In cases where the color of the "Squaw" was pale in the extreme, the same was true of the "Mexican."

A Study of Flintiness.

It is not uncommon to find ears of sweet corn which, when mature, show a marked degree of starchiness in the grains. In 1910 grains from such flinty ears of "Malamo" were grown in alternating rows with those of true sweet kernels of the same variety, and the test showed no immediate influence like that resulting from the crossing of true flint with sweet sorts.

Row 10 of block 1 was planted with flinty "Malamo" grains from an ear grown in the 1910 test; that is, the plant bearing it had true sweet plants upon each side, and presumably many of the grains resulted from pollen from the sweet plants. Of the forty ears, only five were nearly pure sweet, and the thirty-five exhibited all gradations of the flintiness but with the striking feature that there were sweet (wrinkled) grains intermixed with those that were comparatively smooth (starchy).

In row 10, block 2, were grown twenty-six marketable ears, all of which were fully sweet, ten of them being amber, nine white, and seven intermediate. The point to be especially recorded is that the proximity of the flinty strain the previous year gave no manifest influence in this crop.

In row 10, block 4, a true unmixed "Malamo" was used, and there resulted thirty-five white and eighteen amber ears. None showed flinty ears, but there was much crossing in of the "Eight-Rowed Pop," the flinty grains partaking of the ear color in each instance.

EXPERIMENTS WITH SUNFLOWERS.

As a second crop, the ground occupied with peas was planted to sunflowers of the commercial "Russian" sort. In like manner the area that was burned over by the fire that swept away the neighboring barns in July was covered with sunflowers of the same kind and upon these plants some observations have been made.

In the report for last year notes were given as to the number of ray flowers, and an allusion made to the variations in the plan of phyllotaxy. Further observations upon the sunflower lead to the opinion that from the seed (fruit) through the seedling stage to the time when the crop is mature, there is exhibited a wealth of subjects for study in inheritance. The following notes are abstracted from the very fragmentary record made during the growing season.

To illustrate variation, Plate VI gives a face view of two heads gathered from plants grown from seeds from the same commercial packet. The one upon the left is the more ordinary sort in which the seeds are striped from the base to the free broad tip. Upon the right is shown the face of a so-called "black head," that is, the pericarp is of a dark brown, the stripes existing only as suggestions of that which is so well shown in the companion head of the same plate. The number of changes rung upon the seed-markings is very great, so that the seeds of fifty heads gathered at random and threshed together might be separated possibly into their respective groups. In other words, the sunflower in this one point of seed-markings offers an opportunity for extended work in heredity.

The fruits in any one head vary greatly in other factors than color-markings, as, for example, size and shape, those near the rim being shorter and broader than those in the middle of the head, while these latter are quite different from the long slender fruits that are borne near the center. Plate VII is designed to show these variations and also those in stripings. Ten seeds from each of ten heads selected from the rim (shown upon the left) to the center are given upon ruled paper so that the eye can easily distinguish the differences in mind. It is seen at once that the rim seeds (the vertical row upon the left) are much shorter than the central ones, and in some instances both are shorter than those grown midway, as at Nos. 1 and 7. It is also apparent that the amount of dark color averages greater upon the rim seeds. Another feature of the sunflower is that it lends itself easily to a test of vigor as associated with seed maturity. The head develops its seeds from the rim towards the center, and there is usually a

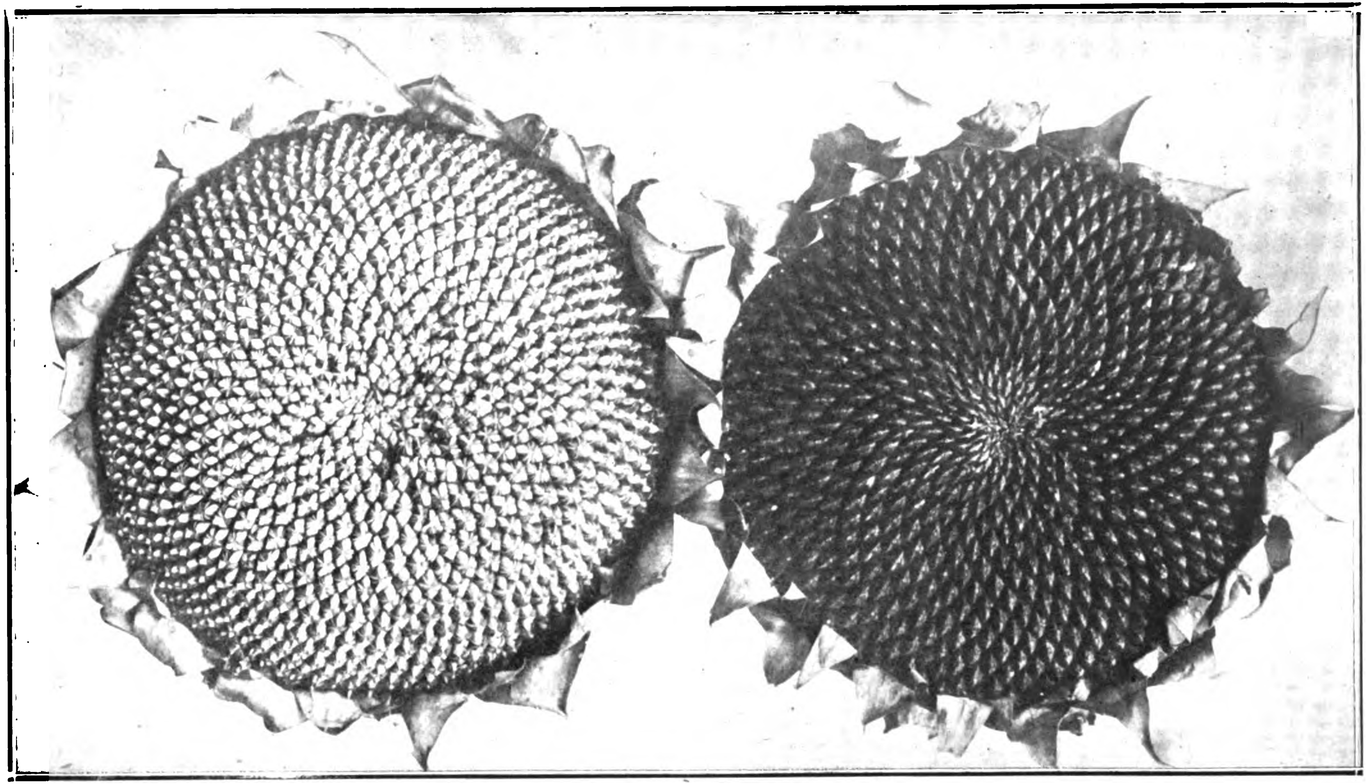

PLATE VI.

Sunflowers. Two heads are shown much reduced; the one upon the left being of the more ordinary sort, while a dark head is given upon the right.

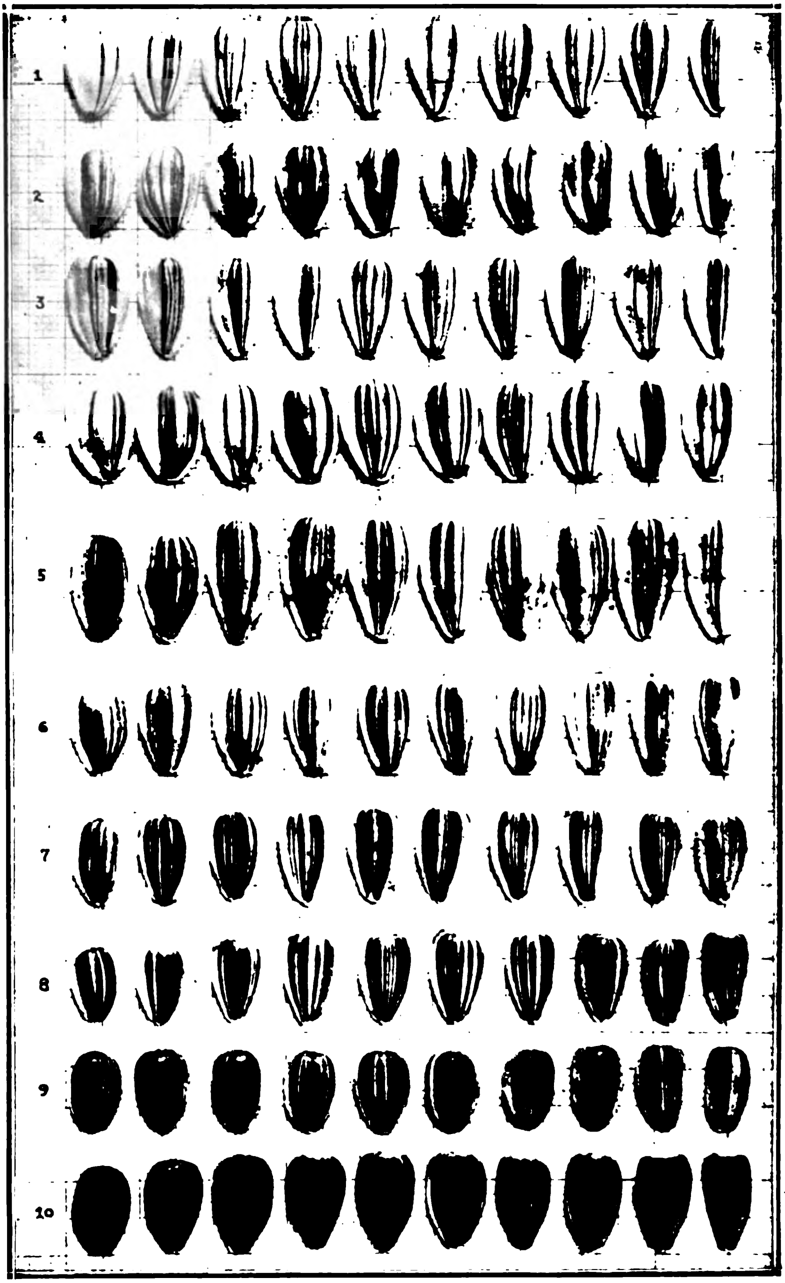

PLATE VII.

Sunflowers. Ten seeds from each of ten heads are arranged in parallel rows beginning with the rim seeds at the left. These rim seeds are shorter than the ones from near the center of the head and more marked with black stripes.

considerable area that never matures its seeds; and therefore, by making the test from rim to center, one can get hundreds of seedlings from the same parent that will represent a varying degree of maturity. Heads can be gathered before they naturally mature, and thereby one can secure a larger percentage of the partially ripened seeds.

The sunflower stem, as a general rule, has the leaves borne in pairs for a few nodes above the cotyledons, shown in the seedling at 1 in Plate VIII. The same is further shown at 2 where the seedling has lost its cotyledons and three pairs of leaves have been cut away. The chief variation in the phyllotaxy consists in an increase in the number to three leaves at a joint, as shown at 3. This augmentation usually comes above a series of opposite leaves but in rare instances there are three cotyledons, and each node bears the three leaves until the opposite or whorled arrangement breaks up into the alternate system. A few plants were found where the leaves were four at a node. Later it is the hope to save seed of such plants fecundated within the head and note the rule of inheritance for such unusual plants. At 4 and 5 are shown two parts of the same plant that had three nodes with three leaves each, followed by a set of three somewhat clustered (at 5), and then comes the alternate type that is almost universal in all plants that are grown under conditions where a sizable head is produced. The portion of stem at 6 shows the first cluster above the regular whorls of three, above which the ordinary alternate type is illustrated. The stem at 7 had a series of four leaves to each whorl, and the transition to the alternate arrangement is shown at the top.

Occasionally there is a stem found that is flattened and often much twisted, upon which the leaves are borne without any manifest order. Such a fasciated stem is shown at 8. Here again is a subject for inheritance study.

From several plants, six feet or more in height, the terminal heads were removed as they began to bloom. In cases where there were no buds, however small in the axils of the leaves, the stems remained upright, the leaves became large, and the petioles of unusual size, particularly their bases, as shown at 9 and 11. For purposes of comparison, two normal stems are given at 10, their heads having been removed to save space. The greater size of the barren stalks is strikingly evident both in diameter of stem and in the remarkable development of the leaf petioles which are two or three times the size of ordinary ones. At 12 is shown a beheaded stem, and from the axil of an upper leaf a small lateral bud was developed, which ordinarily would have remained in an incipient state.

The portion of stem shown at 13 illustrates a case of the beheading of a plant that at the time had four axillary buds in sight midway of the whole length of the stem; these reached the flowering stage before cut short by the frosts. A similar condition obtained in the stem shown at 14, only here the buds were located near the head that was removed. The stem at 15 is another instance of the coming forward of minute axillary buds; in this case also eight are located a short distance below the head which, had it remained in place, might have prevented the development of the smaller supplementary buds.

The fairly large number of sunflower plants made it possible to study the subject of branching, and it is very clear that commercial seed may provide ample representation of a wide range in this respect—a fact that is illustrated in Plate IX. Beginning with 1, a simple unbranched stem with a terminal head, the reader may find a series with the branching increasing by degrees until the form shown at 12 and 13 is reached. These two numbers show the upper and middle portions, respectively, of the same plant, and there was much more of the stem with many long side branches that could not be shown. At 2 there is the main terminal with a single side-bud close to the main head and not well shown in the picture. The stem at 3 shows a case where there is a single lateral branch with a fair-sized head. At 4 is shown a stem with a large terminal and several small lateral buds that probably would not produce blossoms unless the main head were removed; 5 and 6 show two lateral heads that produced flowers and seeds; and at 7 is a very strong stem with many lateral buds, almost without stalks, the upper ones preparing to bloom. At 8 and 9 are shown fairly common instances of several heads situated close to and nearly as large as the terminal one. The stems at 10 and 11 illustrate the considerable length of the stems that bear the lateral heads, the leaves having been removed for the sake of clearness in the engraving. At 12 and 13 is an extreme case of branching where the laterals bear regular leaves. It is gathered from this study

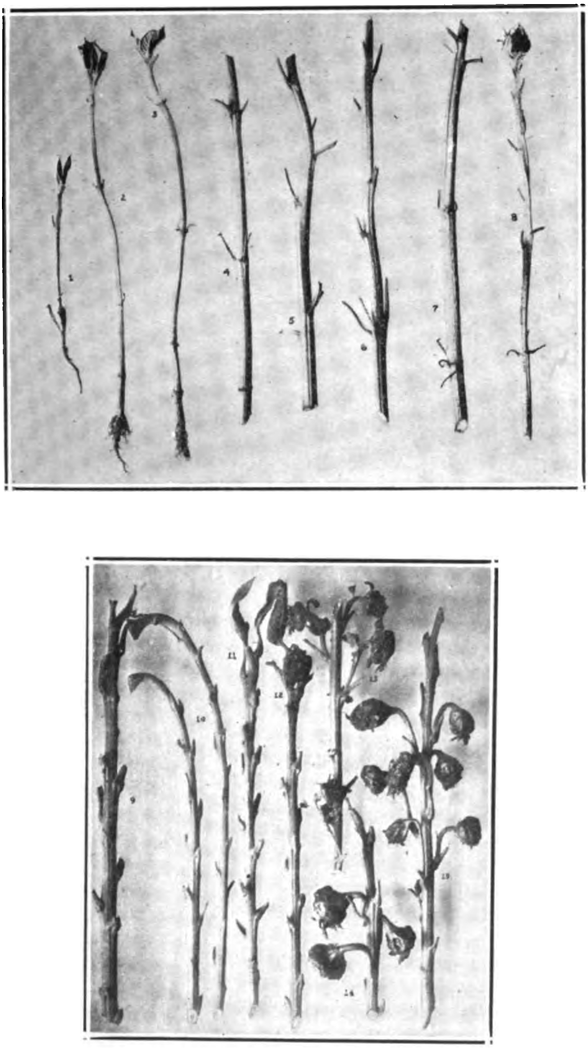

PLATE VIII.

Sunflowers. Leaf arrangement is shown in the upper half where leaves in pairs, threes and fours are given followed by the alternate position usually seen in the upper portion of the stem. The lower part of the plate shows the behavior of decapitated stem and the development of axillary buds that otherwise might remain quiescent.

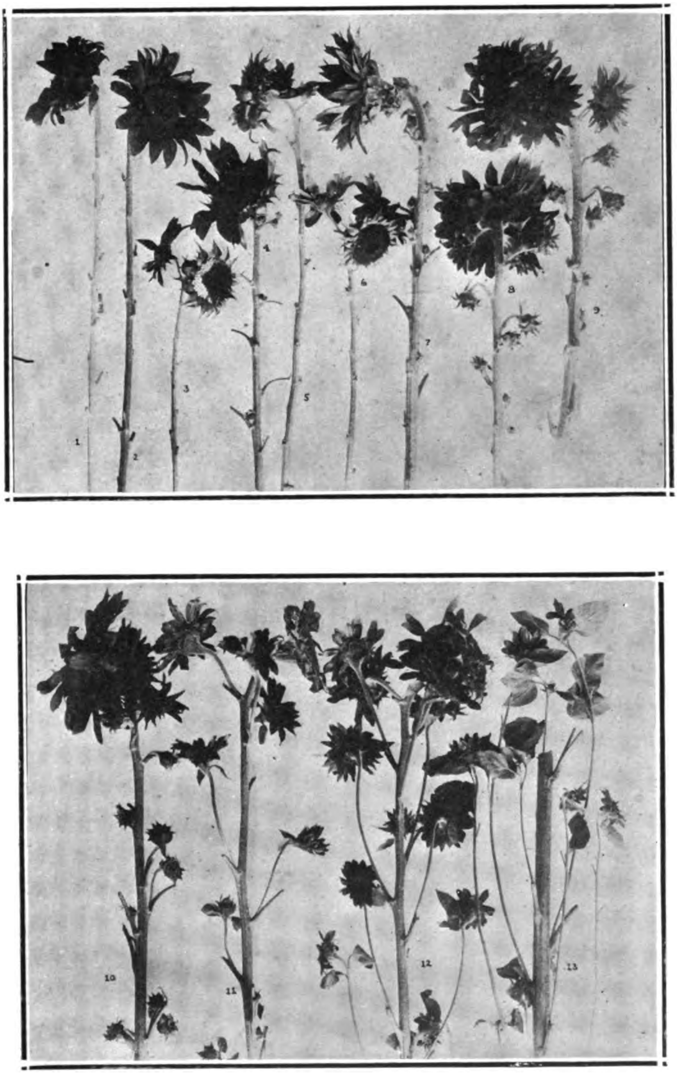

PLATE IX.

Sunflowers. **Flower clusters are shown, ranging from a single terminal head, at 1, to a plant in part shown at 12 and 13, which has very many lateral heads capable of producing seeds.**

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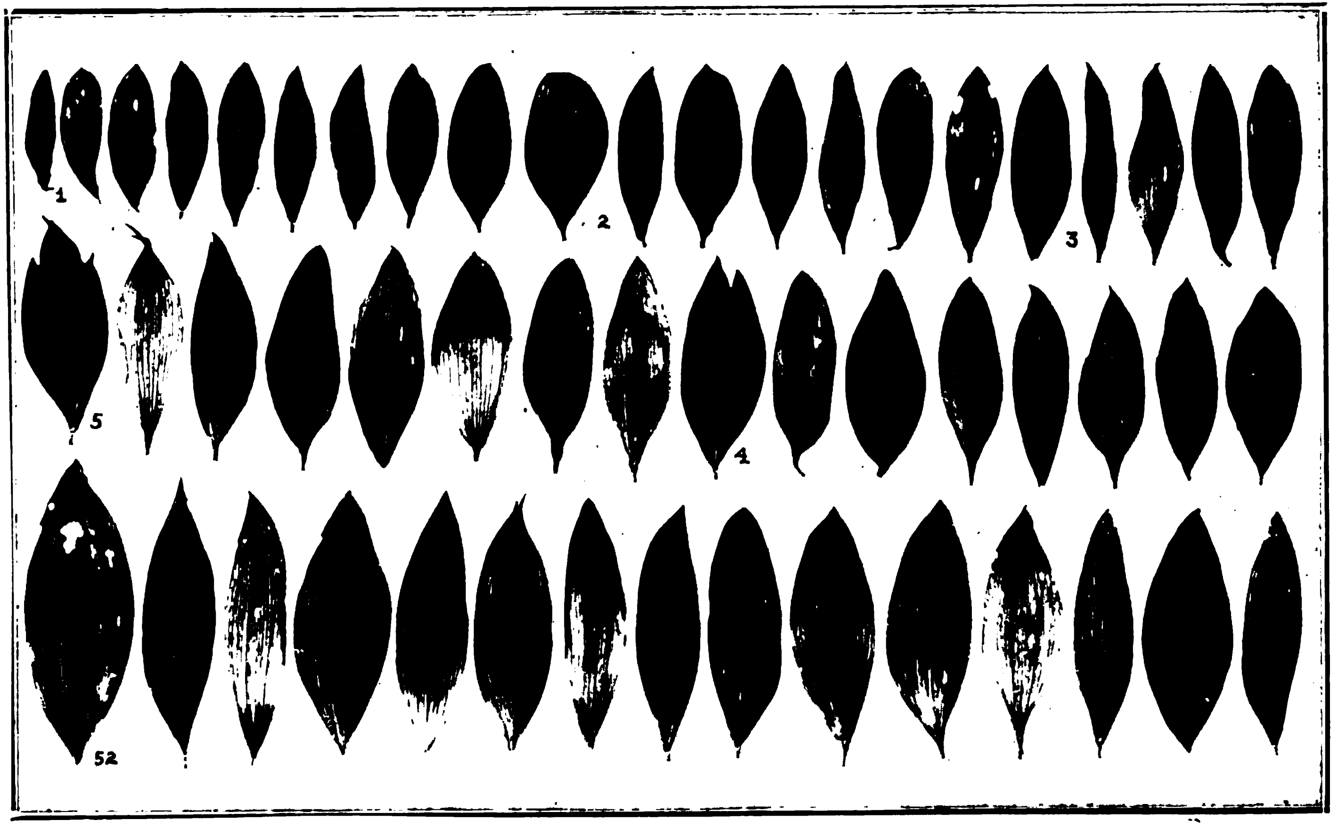

PLATE X.

Sunflowers. Ray flowers are shown from 52 selected heads and are arranged from the shortest, at 1, to the longest, at 52. The breadth also varies greatly even when the lengths are the same, as seen at 2 and 3. At 4 is shown a notched ray and an odd-tipped one at 5.

that there are probably all gradations between the single head form and the multiple head type in the common sunflower.

While the ray flowers of any single head (or heads) of the same plant are much alike, the range in variation in the species (*Helianthus annuus* L.) is great and an attempt is made to show this in Plate X, where a single ray from each of fifty-two heads of good size is shown. The samples are arranged upon the basis of length only, beginning at the upper left hand corner and ending at the left in the lowest row. When Nos. 1 and 52 are compared, the range is striking, and should the breadth be the dimension considered, the variations are noticeable even when the length remains practically the same, and therefore the two at 2 and at 3, for example, are quite unlike.

There are many other differences not shown in a photograph of a set that was taken after the specimens had been pressed flat and dried. Thus, many heads have the rays upright and nearly straight, while others may be twisted upon the longitudinal axis or turned down and almost coiled from the tip. Some heads have thin flat rays; others are almost plicate, but the folds of such are not well shown in the plate. Again, occasionally the rays are with two lobes at the tip, as shown at 4, or two-notched, as seen at 5, where the ray is approaching somewhat the five-lobed structure of the disc flowers of the same species.

Some records have been made as to the number of ray flowers in the sunflower heads:

1. UNBRANCHED.

Twenty plants, 8 ft. high, heads 8 in. in diameter, range 41 to 62, average, 53.4.

Twenty plants, 6 ft. high, heads 6 in. in diameter, range 37 to 55, average, 45.4.

Twenty plants, 4 ft. high, heads 4 in. in diameter, range 27 to 39, average, 33.1.

2. BRANCHED.

Plant numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Averages.
Terminal heads	58	35	36	43	46	35	50	34	46	41	55	45	34	61	45	45	54	45	46	46	54	51	45.7
1st lateral heads........	30	22	30	24	26	24	29	21	35	29	37	30	26	32	24	34	27	24	30	30	33	23	28.2
2d " "	33	21	29	21	29	35	32	23	25	32	..	35	28	40	28	31	28	23	31	32	38	24	29.4
3d " "	35	20	28	23	..	..	28	22	33	29	..	32	30	39	26	28	29	21	28	28	36	22	28.3
4th " "	34	19	30	25	..	..	30	..	31	31	..	35	33	43	27	28	26	22	23	31	37	21	29.2
5th " "	37	18	29	28	..	..	27	..	31	26	..	33	27	..	25	23	21	22	26	27	33	21	26.7
6th " "	33	20	..	31	..	..	..	..	29	30	..	32	24	..	26	23	..	21	21	24	34	20	26.3
7th " "	31	..	..	27	..	..	..	..	30	28	..	28	..	..	23	23	..	..	21	28	34	18	26.5
8th " "	33	..	..	27	..	..	..	..	30	27	..	32	..	..	26	22	..	..	26	28	..	16	26.7
9th " "	31	20	..	24	..	..	..	..	29	22	..	34	..	..	25	23	..	..	25	..	..	17	25.0
10th " "	31	..	..	27	..	..	..	..	33	22	..	..	..	..	21	..	..	..	20	..	..	20	24.9
11th " "	..	..	..	24	..	..	..	..	32	20	..	..	..	..	21	..	..	..	22	..	..	..	23.8
12th " "	33	18	..	25	..	..	..	..	33	24	..	..	..	..	..	..	..	..	26	..	..	..	26.5
13th " "	..	..	..	29	..	..	..	..	24	21	..	..	..	..	..	..	..	..	..	..	..	..	24.7
14th " "	30	19	..	25	..	..	..	..	28	21	..	..	..	..	..	..	..	..	..	..	..	..	24.6
15th " "	..	..	..	23	..	..	..	..	30	22	..	..	..	..	..	..	..	..	..	..	..	..	25.0
16th " "	31	..	..	25	..	..	..	..	20	18	..	..	..	..	..	..	..	..	..	..	..	..	23.5
17th " "	25	..	..	28	..	..	..	..	22	21	..	..	..	..	..	..	..	..	..	..	..	..	24.0
18th " "	21	..	..	26	..	..	..	..	28	23	..	..	..	..	..	..	..	..	..	..	..	..	24.5
19th " "	..	..	..	31	..	..	..	..	24	23	..	..	..	..	..	..	..	..	..	..	..	..	26.0
20th " "	..	..	..	32	..	..	..	..	24	23	..	..	..	..	..	..	..	..	..	..	..	..	26.3
21st " "	..	..	..	31	..	..	..	..	30	23	..	..	..	..	..	..	..	..	..	..	..	..	28.0
22d " "	..	..	..	28	..	..	..	..	21	21	..	..	..	..	..	..	..	..	..	..	..	..	23.3
23d " "	..	..	..	21	..	..	..	..	22	21	..	..	..	..	..	..	..	..	..	..	..	..	21.3
24th " "	..	..	..	22	..	..	..	..	22	20	..	..	..	..	..	..	..	..	..	..	..	..	21.3
25th " "	..	..	..	..	..	..	..	..	24	13	..	..	..	..	..	..	..	..	..	..	..	..	18.5
26th " "	..	..	..	..	..	..	..	..	21	..	..	..	..	..	..	..	..	..	..	..	..	..	21.0
27th " "	..	..	..	..	..	..	..	..	20	..	..	..	..	..	..	..	..	..	..	..	..	..	20.0
28th " "	..	..	..	..	..	..	..	..	21	..	..	..	..	..	..	..	..	..	..	..	..	..	21.0
29th " "	..	..	..	..	..	..	..	..	13	..	..	..	..	..	..	..	..	..	..	..	..	..	13.0

It is seen that the number of rays drops very rapidly after the terminal; and where the number of laterals is great, the ray flowers are comparatively few. 'With a much larger number of instances, the ray flowers of the small heads and the terminals upon ill-conditioned stunted plants may be found to range between 13 and 21, as those of the terminals of unbranched plants appear to swing between 34 and 55.

Concerning the phyllotaxy of the sunflower, the following notes are given in tabular form. The first column gives the height of plant and the following are for the first node and so on up the plant to the top, the last column containing the number of rays in the terminal head. The successive figures indicate the number of leaves at each node.

Height of plant in feet.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Rays.
3½....	2	2	2	2	1	1	1	1	1	1	1	1	1	1	..	..	..	..	34
2......	2	2	2	1	2	1	1	1	1	1	1	..	..	..	..	..	..	..	16
3½....	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	..	28
3......	2	2	2	1	1	1	1	1	1	1	1	1	1	..	..	..	..	..	20
4......	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
3......	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21
2......	2	3	3	3	3	3	1	1	1	1	..	..	..	..	..	..	..	..	20
2¾....	2	2	3	1	1	1	1	1	1	..	1	1	1	1	..	..	..	..	22
2......	2	2	2	..	1	1	1	1	1	1	1	1	1	1	..	..	..	..	15
1¼....	2	2	2	½	½	1	1	1	1	..	..	..	..	..	..	..	..	..	17
1¼....	2	2	2	..	1	1	1	1	1	1	..	..	..	..	..	..	..	..	14
2......	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	..	..	25
7½....	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1+	64
6......	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1+	55
6......	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1+	62
6½....	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1+	60
6½....	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1+	55
7......	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1+	45
7......	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	48
7......	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1+	49
7......	2	2	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1+	45
4......	2	2	½	½	1	1	1	1	1	1	1	1	1	1	1	1	1	..	..
1½....	2	2	2	2	1	1	1	1	1	1	..	..	..	..	..	..	..	..	13
4......	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	..	..	..	..
2......	2	2	2	2	1	1	1	1	1	1	1	1	1	..	..	..	..	..	18
1¾....	2	2	2	2	2	1	1	..	..	..	..	..	..	..	..	..	..	..	..
1¾....	2	2	2	2	1	2	1	1	1	1	..	..	..	..	..	..	..	..	..
2......	2	2	2	2	2	2	1	2	1	1	1	..	..	..	..	..	..	..	..
3......	2	2	2	½	½	1	1	1	1	1	1	1	1	1	..	..	..	..	21
4......	2	2	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	..	..
3......	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	..	..	..	21
1½....	2	2	2	2	2	1	1	1	1	1	..	..	..	..	..	..	..	..	..
2......	2	2	3	4	4	1	1	1	1	..	..	..	..	..	..	...	..	..	..
1¼....	2	2	2	1	1	1	1	1	1	..	..	..	..	..	..	..	..	..	..
3......	2	2	2	1	1	1	1	1	1	1	1	1	1	..	..	..	..	..	..
2......	2	1	1	2	1	2	1	2	1	1	1	1	1	..	..	..	..	..	..
3......	2	2	4	2	1	1	1	1	1	2	1	1	1	1	..	..	..	..	..
2......	2	2	3	1	1	1	1	1	1	1	1	1	1	1	1	..	..	..	..
3½....	2	2	1	1	1	1	1	1	1	1	1	1	1	..	..	..	..	..	28
5......	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1+	..	40
7......	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1+	..	40
7......	2	2	4	1	1	1	..	..	..	..	..	..	..	..	..	..	..	..	42

A STUDY OF PEPPERS.

The common garden pepper (*Capsicum annuum* L.) has been a subject for investigation for the past few years, the chief work thus far being an attempt to map out its factors and their relative importance as lines of study of inheritance. During the growing season of 1911 as full a list as possible has been grown of the commercial varieties of peppers. There was the usual disappointment attendant upon this work in the large number of packets of seeds that failed to produce any seedlings, but nevertheless the list numbered 101.

In connection with the study of these sorts, a printed blank was used, a sample of which is herewith presented. It will be noted that the points for observation are grouped under the following heads: seed, seedling, plant, stem, leaf, flower, peduncle and fruit.

In the following pages of a report upon the work in progress the same sequence of topics will be followed.

RECORD BLANK FOR PEPPERS.

Record number.......... Date of planting.........; of setting.........; of observations...........
SEED: Source........; year.........; weight.........; size.........; shape........; color........; number in a fruit.........
SEEDLING: Hypocotyl—length........; thickness........; color.......
Cotyledons—length.........; breadth........; color.......
PLANT: Size........; branches few, many.
STEM: Upright, prostrate; size........; color........; hairy........;
Internodes—length........; shape.........
LEAF: Single, fascicled; size—petiole.......; blade.......; color.......
FLOWER: Calyx—size.........; shape.........; color.........; cup, saucer, depressed; lobes.........
Corolla—size........; shape........; color........; lobes.........
Stamens—size........; shape........; color........; anthers........; pollen.........
Pistil—size.........; shape.........; color.........; lobes.........
PEDUNCLE: Length, thickness, fleshy; pendent, upright.
FRUIT: Single, fascicled; number, size.......; color—when green.......; when maturing........; when ripe; pungent—mild; point—single, divided; divisions shallow, deep; thickness of flesh.......; placentæ........; shapes—ovate, elliptical, oblong-linear, oblate, oblong, truncate, spherical, sub-conical, prismatic, squarish, sub-truncate, turbinate, cherry-shaped, heart-shaped, deeply lobed, furrowed, wrinkled.
MISCELLANEOUS: Stock pure, mixed, true to name, not; variety distinct, not.

Pepper Seeds.

The seeds of peppers are flat, irregularly lenticular and, generally speaking, straw colored; they are heavier than water, that is, good ones, and the floating method may be used for separation. In size, the seeds of the different kinds vary greatly, as is well shown by Plate XI., where fifteen varieties (their record number beneath) have been selected to make a series beginning with a small sort (No. 125) received from Reichardt & Schulte, Houston, Texas, to those of a kind (No. 64) kindly sent by Mr. E. Stearns, C. Juarez, Mexico—a difference that is most striking. No. 72, also very small, was furnished by the United States Department of Agriculture, as No. 22803, while No. 86 was found in a local market as a sort with large pale green fruits. The 101 is from the "Chili Pequin," while 100 is "Mexican Chili," 30 is "Tabasco," and 110 "Paprika." No. 32 is a strange fruited sort grown for ornament under the name of "Wrinkled," and 47 is from "Tom Thumb," a dwarf kind. A good average seed is shown at 17, and represents the "Neapolitan," a standard commercial sort in New Jersey.

Variation in the size of pepper seeds that occurs when two sorts are crossed having different dimensions of seed is shown in Plate XII. In the upper left-hand corner is shown a group of eight normal seeds of the "Black Nubian" (5), and next to its right an equal number of the "Coral Gem" (11). When studied closely, a real difference is seen to exist, the "Nubian" being decidedly larger. The other forty-three groups represent the seeds of as many plants of the cross of the "Nubian" upon the "Gem" as expressed by the fraction 5/11, and here representing the second generation. No attempt has been made to arrange the group according to size, but they are placed in the order of the plants in the field from one to forty-three. While it is doubtful whether any crossed plant had seeds smaller than those of the "Gem," it is quite apparent that many are larger than the "Nubian." It remains to be determined how representative such a set of seed-groups may be of the cross in question and the parents as well.

In the accompanying table it is seen that in number of seeds the range is from 42 to 375, and when these figures are multiplied by the number of fruits borne, it is evident that the seeding capacity of a single plant is often far up in the thousands.

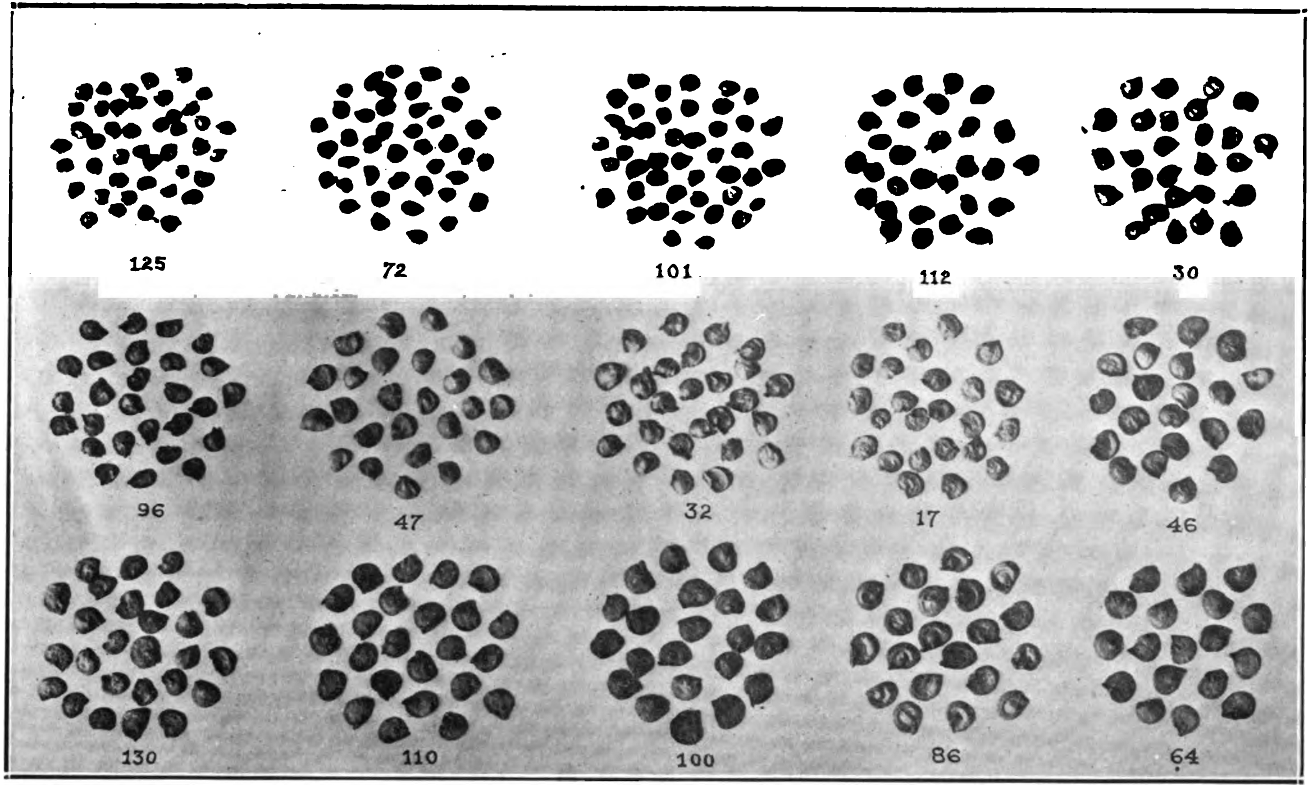

PLATE XI.

Pepper Seeds. Fifteen kinds are shown in groups that illustrate somewhat the range in the size and shape of commercial pepper seeds.

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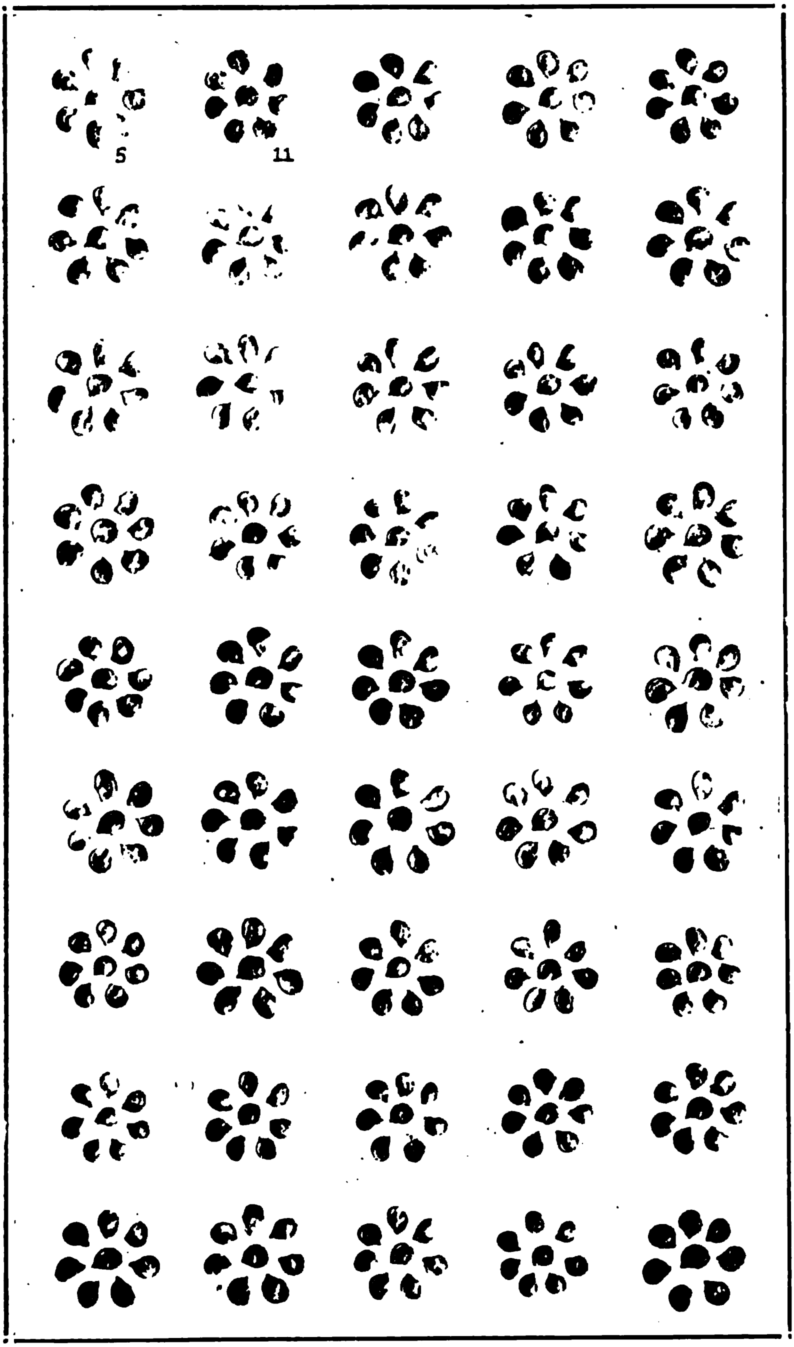


PLATE XII.

Pepper Seeds. The seeds of the two kinds, "Black Nubian" (5) and "Coral Gem" (11), are shown at 5 and 11, respectively, and the remaining portion of the plate is occupied with 43 groups of seeds from as many plants of the cross of the above two sorts. The range in size is considerable.

The range in number of seeds within the fruits of any variety is great, as the following record shows:

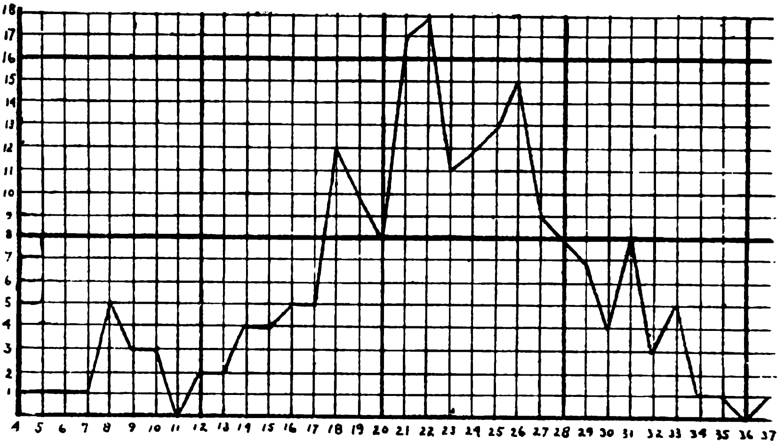
TABLE OF FRUIT MEASUREMENTS SHOWING SEEDINESS.

Record Number.	Weight.	Measurements.	Specific Gravity.	Number of Seeds.
75	5 gms.	8 cc.	.62	74
7	5 "	8 "	.62	110
77	6 "	8 "	.75	155
20	7 "	10 "	.70	137
71	8 "	10 "	.80	142
46	9 "	10 "	.90	62
6	10 "	11 "	.91	111
103	12 "	10 "	.83	107
110	14 "	25 "	.56	146
95	15.5 "	24 "	.64	181
132	16 "	18 "	.88	192
65	26 "	45 "	.57	117
17	35 "	65 "	.54	166
45	50 "	110 "	.45	216
111	55 "	110 "	.50	375
64	64 "	145 "	.44	350
2	70 "	120 "	.58	85
115	71 "	132 "	.54	61
26	73 "	130 "	.56	244
87	73 "	125 "	.58	281
120	75 "	100 "	.75	214
134	92 "	140 "	.66	301
26	112 "	217 "	.51	42

The seeds in two hundred pods from a lot of peppers received from Mexico (No. 125), and the smallest that have thus far been studied, have been counted with the result as shown in the curve below. It is seen that the seeds varied from 4 to 37. During this determination, a count was made of the seeds of fifty of the smallest fruits, as large as currants, showing a range from 4 to 31, while a corresponding fifty of the largest gave a range of 15 to 35. In these two sets the mean was, respectively, 15.26 and 24.5, and illustrates that the small fruits of the same kind have fewer seeds than large ones.

The irregularity of the line of the curve indicates that the number 200 is altogether inadequate, and possibly a thousand or more might be needed to smooth off the peaks and fill up the valleys. It seems possible that the descent of the curve upon the left would be more abrupt than upon the right and the arithmetical mean, therefore, some distance to one side of the greatest frequency number, 22.

It must be kept in view that the number of seeds is a matter that depends upon the meeting of the gametes, and this is one somewhat governed by chance, there being many factors that enter into the accomplishment of fertilization, as weather, insects, winds, to say nothing of individual plant peculiarities.



Pepper Seedlings.

The young pepper plants, during their first few weeks of growth, show several variable factors in cotyledons, hypocotyl, first leaf, etc., and samples of the kinds grown in the greenhouse for field setting have been pressed for study. It seems likely that the seedling plants show qualities that will enable the close observer to predict somewhat of the nature of the plant that may develop from it. For example, some kinds of seeds germinate more quickly than others, and that may be an index of earliness. Some seedlings have a short hypocotyl, and the seed-leaves are comparatively near to the ground, suggesting that the size of the mature plant is fore-shadowed in the seedling. In like manner a forecast is found in the first true leaves as to their arrangement, whether simple or fascicled, and, of course, much as to the probable size and form is in evidence. Again, it is not unlikely that the prevailing color may be determined from that which is shown in the hypocotyl.

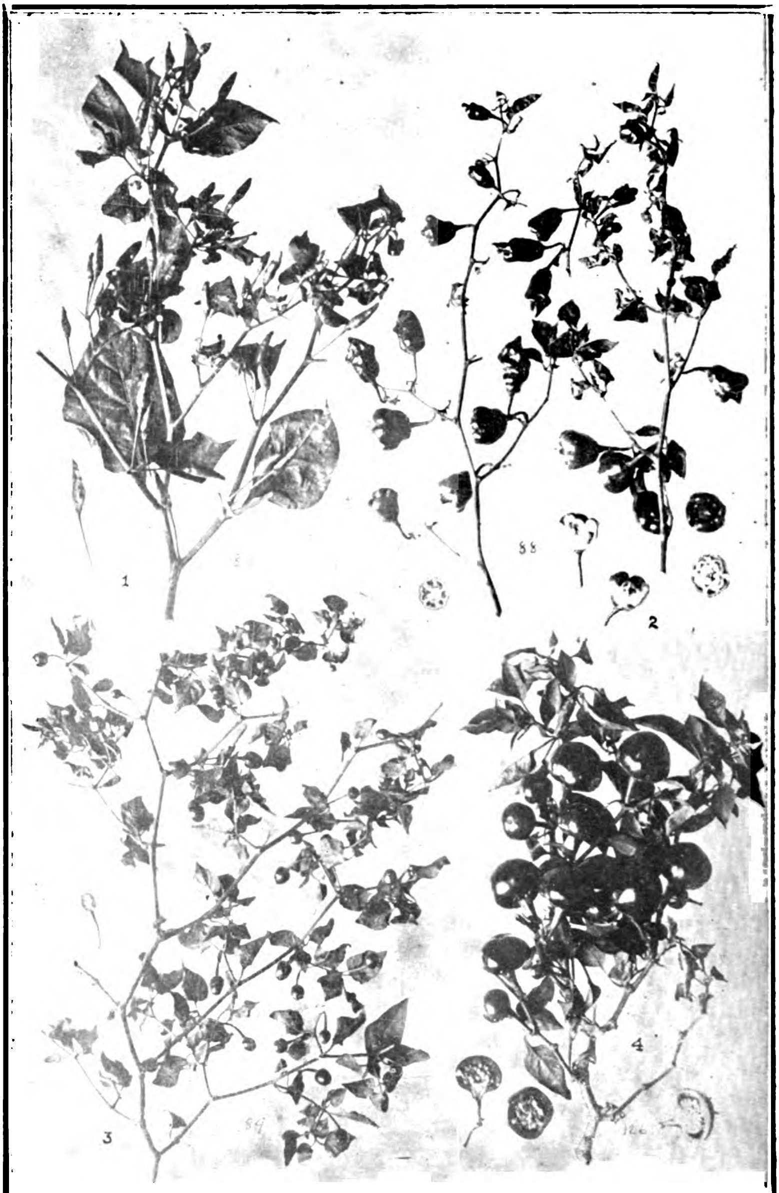


PLATE XIII.

Pepper Plants. **At 1 is shown a spray of "Frotscher's Tabasco" (84), and at 2, the "Scallop" pepper. The "Bird's Eye" (89) is at 3, and a "Mutant" (126) is given at 4.**

Pepper Plants.

The pepper plant as a whole has been considered with some degree of fullness in previous annual reports. Whether a plant is low and upright, a true dwarf or spreading upon the ground is a matter of ready observation, because these two types are in striking contrast with those high-growing kinds that comprise the standard group and includes the bulk of the plants that are grown by the pepper farmers in producing the supply of large-fruited sorts.

Plate XIII. shows four kinds of plants that have not been previously illustrated. At 1 is seen a spray from a tall plant, conspicuous for its stiff upright branches with very large lower leaves, while the others are comparatively small, widely separated, thus making the slender upright fruits conspicuous in all stages of their development. This is "Frotscher's Tabasco," and is a kind abounding in pungency, and is popular in the far south, for the making of pepper sauce, etc.

At 2 is a spray of a very different type of pepper, as the plant, while large, has the branches so slender and weak that they hang out laterally, and the irregular fruits are pendent upon their long peduncles. This is called the "Scallop" pepper from the general shape of the mature fruit; it is peculiarly pungent and is chiefly grown for ornament under glass for room decorations.

The branch at 3 is from a spreading type of plant, the photograph having been taken with the spray placed bottom side up. The dichotomous branching is well shown, and likewise the great development of nearly heart-shaped leaves—quite unusual among peppers—often obscuring the crops of small fruits. This is called "Bird's Eye" pepper, a general term for many small fruited sorts, and was kindly furnished by Professor P. H. Rolf director of the Florida Experiment Station.

Quite in contrast with all the above, there is the type illustrated at 4. This came as a sport (mutant?) in a block of a cross of the "Sweet Spanish" upon the "Red Cluster," and is far adrift from either parent. The plant is a bushy, round-topped dwarf with the many branches bearing the handsome medium-sized fruits upright and showily above the foliage. The fruits are sweet, almost free from any trace of pungency, and with a firm thick wall. Whether such a type would be of practical service to the pepper grower is an open question.

Notes Upon Some Pepper Crosses.

"Bell-Cherry." The "Large Bell" (2) upon "Red Cherry" (20) is shown at 2/20 in Plate XIV., where the fruits are photographed after maturity and are more wrinkled than when freshly gathered, as was the case with the parents upon their right and left. The fruits of the cross were fairly uniform upon the same plant, that is, the form is comparatively constant, but the size exhibits a wide range; thus fruits that are not favorably situated for obtaining nourishment may remain small and, again, the lack of sufficient fecundation and the consequent production of few seeds may result in a small fruit. Upon the other hand, the fifteen plants of this cross showed two leading types of fruits; that is, ten short and five long, four representatives of the former and two of the latter being shown. In like manner three were smooth and twelve ridged. The relative size of the fruits as compared with the "Bell" upon the left and the "Cherry" upon the right is fairly well indicated in the engraving. A good-sized "Bell" is near 8 cm. both in length and breadth, and with usually three placentæ and ribs, but often four, and possibly five-lobed. The flat type of the cross follows this parent closely in these factors, and the long type carries the smooth surface factor of the "Cherry" and the lower number of placentæ, often only two.

"Neapolitan-Long Red Cayenne." The lower half of Plate XIV. shows the fruit of the cross between "Neapolitan" (17) and "Long Red Cayenne" (6) in which both parents are unlike in length and breadth. The "Neapolitan" is one of the leading commercial sorts, the fruits being of good marketable size, and the plants produce them in large numbers and early in the season. The fruit of the mother plant, as the name indicates, is long combined with narrowness. With a fairly thick wall, it holds its shape well and becomes a very handsome dark red fruit remarkable for its tapering form. The effect of the "Neapolitan" is not strongly marked, as is shown by the group of fruits given at 17/6. However, when a measure is taken of the diameter, it is found to be near 25 mm. at the base to 15 mm. for the "Long Red," and 50 mm. for the "Neapolitan." In length, the cross exceeds that of its larger parent, although this is not apparent to the eye because of the greater breadth of the cross. The "Neapolitan" is a lobed type and the tip is often much depressed as if

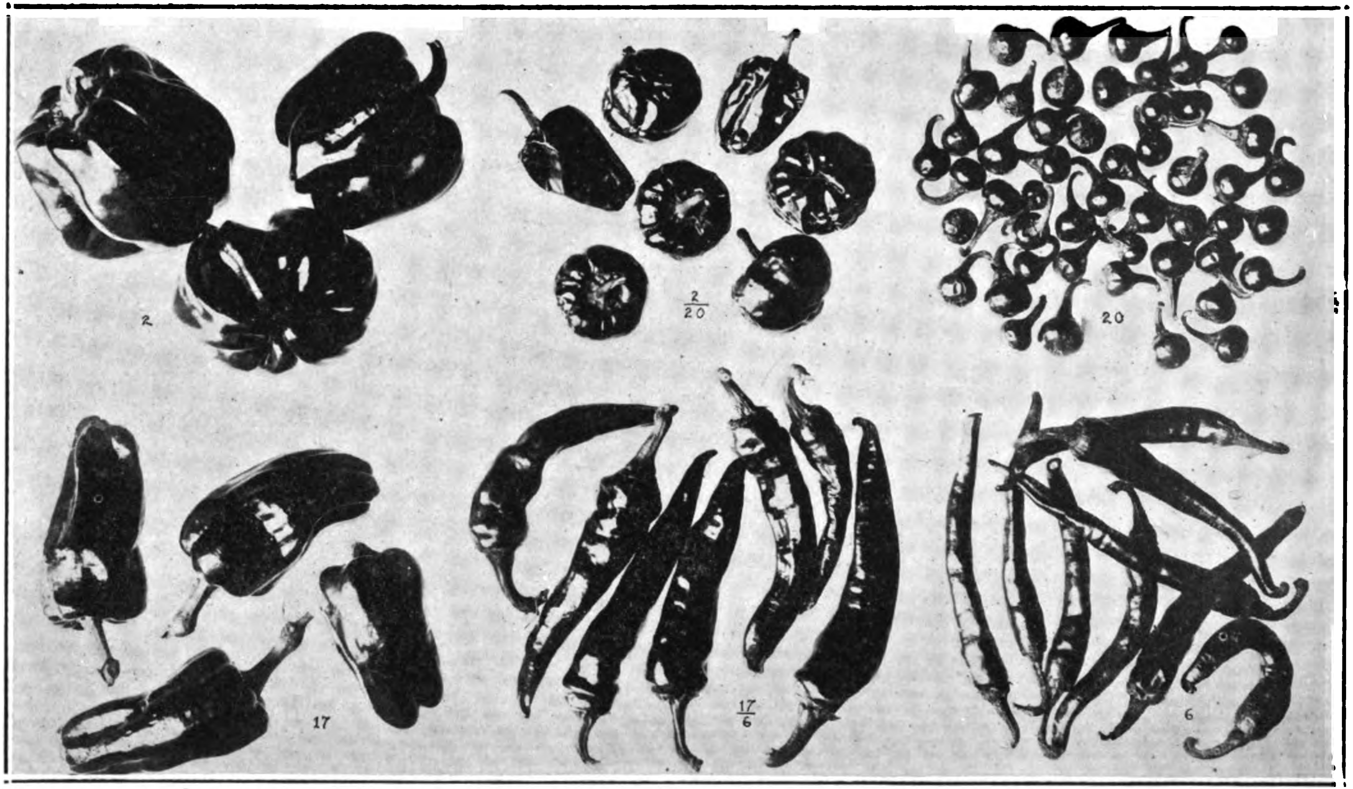


PLATE XIV.

Pepper Crosses. The upper half shows the "Large Bell," at 2; the "Red Cherry," at 20; and the cross of the "Bell" upon the "Cherry" ($\frac{2}{20}$) between them. In the lower half is the "Neapolitan," at 17; and the "Long Red Cayenne," at 6; with the cross ($\frac{17}{6}$) in the middle.

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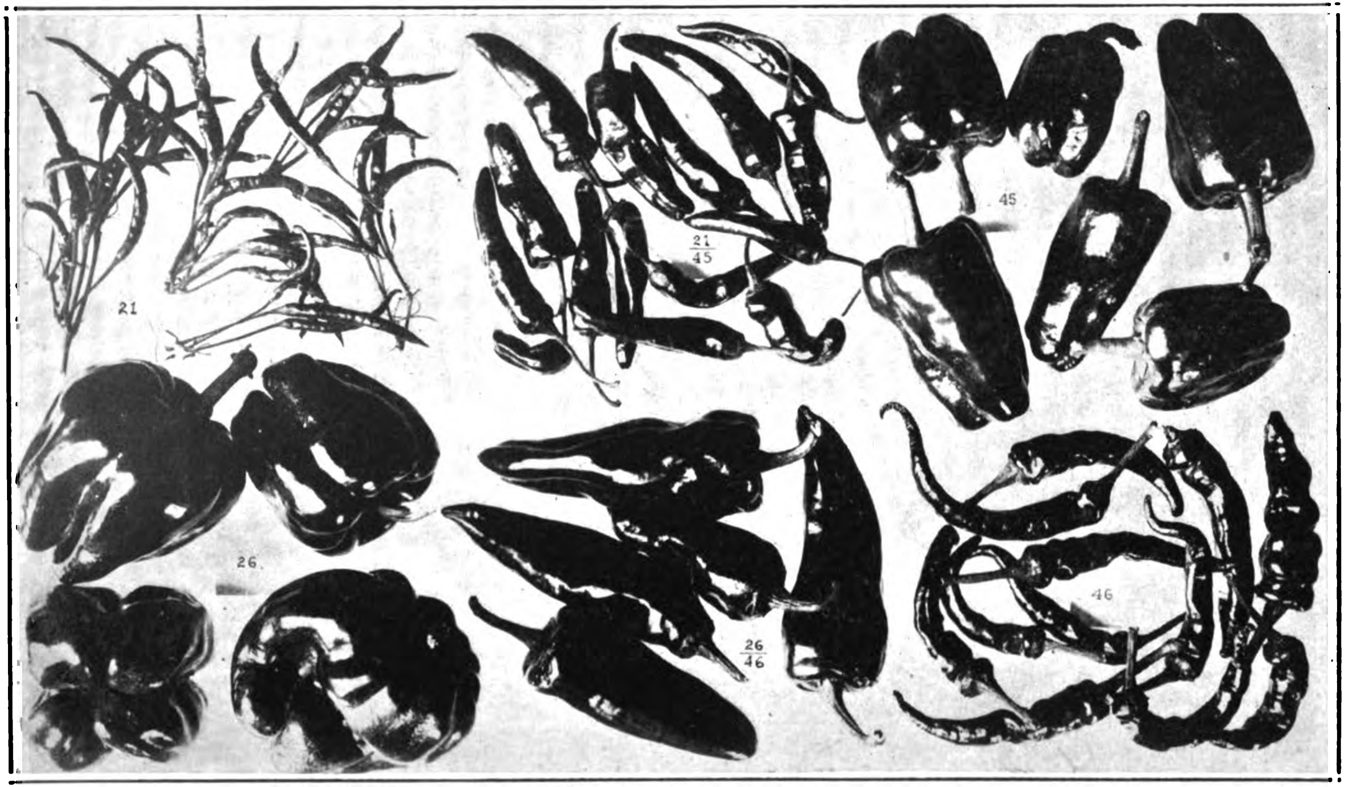

PLATE XV.

Pepper Crosses. The upper half shows the "Red Cluster" (21) upon the left; "Peddrick's Extra Early Prolific" (45) upon the right; and the cross ($\frac{21}{45}$) between them. In the lower half are "Sweet Spanish" (26) upon the left; "New Red Hot" (46) upon the right; and their cross ($\frac{26}{46}$) between them.

subjected to a restraining influence, a condition that obtains generally with all fruits that are of the "bull nose" or "cat face" type, where there are three or four (or more) seed-bearing placentæ. In the cross the fruits are two-celled and the tip pointed, so that the factor for length is apparently free to act and the result is a fruit that has excessive length, as stated.

"Red Cluster-Peddrick's Extra Early Prolific." The parents, with this cross, are shown in the upper half of Plate XV. In this case the cross is between two widely different types of fruits; the male parent (see 21) is very slender, and the mother (see 45) is one of the standard large-fruited sorts. The following are some weights and measurements that were taken of ten fruits of each of the three groups:

"Red Cluster," 10 fruits weighed 9 grams.	
" " 10 " measured 10 cc.; specific gravity	90.00
" " 10 " flesh only, measured 9.5 cc.; specific gravity,	93.67
"Peddrick's Extra Early Prolific," 10 fruits weighed 430 grams.	
"Peddrick's Extra Early Prolific," 10 fruits measured 850 cc.; specific gravity	50.58
"Peddrick's Extra Early Prolific," 10 fruits, flesh only, measured 510 cc.; specific gravity	84.32
The Cross, 21/45, 10 fruits weighed 84 grams.	
" " 21/45, 10 fruits measured 140 cc.; specific gravity	60.00
" " 21/45, 10 fruits, flesh only, measured 105 cc.; specific gravity	80.00

In other words, "Red Cluster" is very solid and it is nearly the weight of water; that is, there is but little air space which to some extent is overcome by the seeds which quickly sink in water. The "Peddrick" is an inflated fruit that rides upon the water with a half above the surface. Commercial peppers generally of the type in question, and that includes the major part, are half air and the other half is chiefly water, the whole carrying a flavor and an amount of pungency that frequently decides in favor of one kind or another for the crop to be grown.

The influence of each parent is brought out by a study of the three groups in the plate. In matter of length, for example, the average of 60 mm. for the "Red Cluster" is increased to 75 mm. in the cross, which practically equals the length of the large-fruited parent. Here, somewhat opposite to the last cross cited, the restraint in longitudinal growth resulting in the depressed tip does not produce marked results in elongation of the crossed fruits. In width, at the base, the 8 mm. of one parent and the 70 of the other, results in 17 mm. for the cross, in which case the smaller fruit has far greater potency than the large one, and conforms to the general rule with inflated fruits.

A brief study of the fruits and their seeds was made; for example, Plant 16 had a great variety of fruits, ranging from a long lance shape, much longer than the 21 and exceeding the 45, to fruits that were tri-lobed and quite short. (The ratio between the lance-pointed and tri-lobed fruits was not determined.) Fruits that are below normal size have, as a rule, a small quota of seeds, which may have much to do with the reduced size. As a matter of fact, one of the ten fruits in the set examined had but one seed, and was much bent and contorted. While the amount of seed production may have no control upon the type of fruit, it seems evident that the size and its distortions are influenced thereby.

"Sweet Spanish-New Red Hot." The lower half of Plate XV. shows sample fruits of the above cross at 26/46, with the pollen parent to the left (26) and the mother at the right (46). Here are very striking differences in the fruits, some of which are shown in the following table of weights and measures:

"Sweet Spanish," 10 fruits weighed 1320 grams.
" " 10 " measured 2550 cc.; specific gravity...... 51.76
" " 10 " flesh only, measured 1425 cc.; specific gravity 92.16

"New Red Hot," 10 fruits weighed 104 grams.
" " " 10 " measured 140 cc.; specific gravity........ 74.30
" " " 10 " flesh only, measured 110 cc.; specific gravity 94.54

The Cross, 26/46, 10 fruits weighed 340 grams.
" " 26/46, 10 " measured 620 cc.; specific gravity....... 54.84
" " 26/46, 10 " flesh only, measured 350 cc.; specific gravity 91.42

It is seen that the specific gravity of the flesh alone is quite uniform, as may well be expected, as it consists chiefly of water with more or less entangled air in the cells and a considerable percentage of seeds associated with it. The solidity (specific gravity) of the "Red Hot" is much greater (74) than that of the pollen parent (51); in round numbers as 3 to 2, and that of the

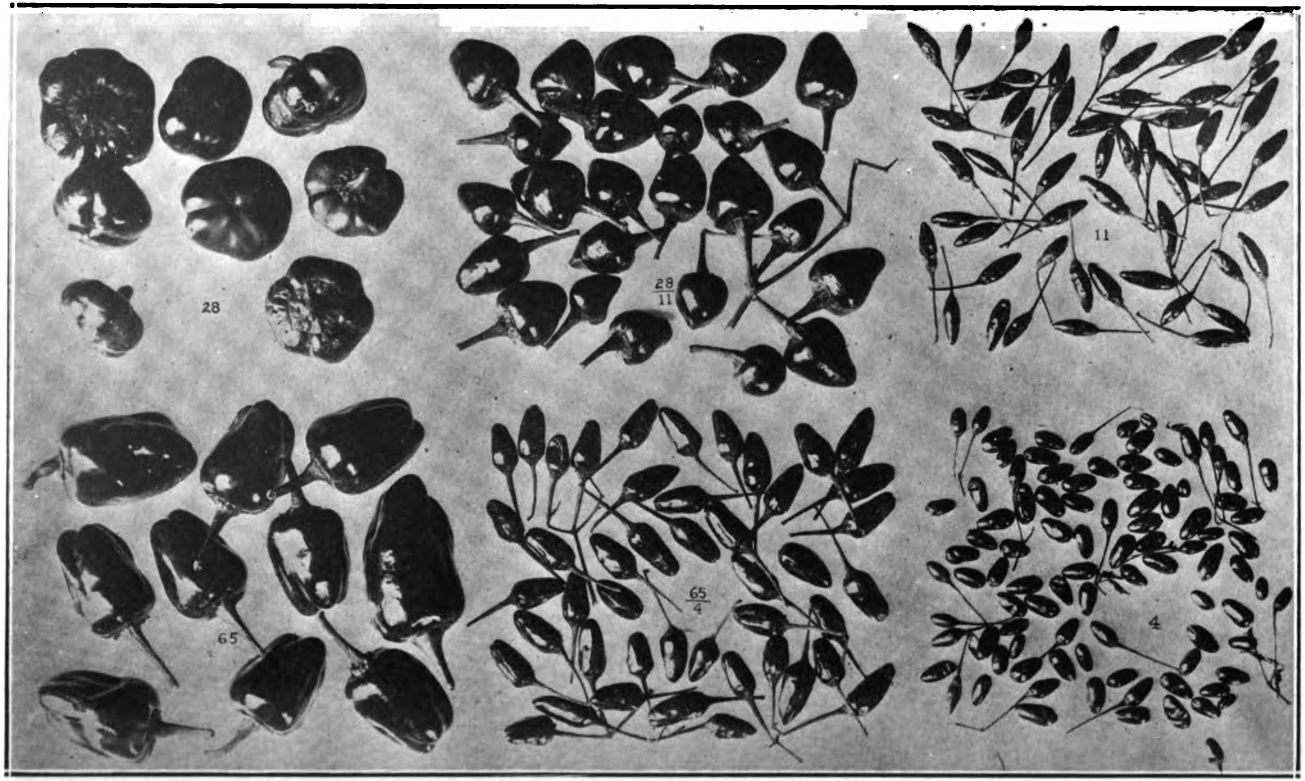

PLATE XVI.

Pepper Crosses. The upper half shows the "Squash" (28) upon the left; "Coral Gem" (11) upon the right; and the cross ($\frac{28}{11}$) between them. In the lower half, "Ruby Pearl" (65) is upon the left and "Bird's Eye" (4) upon the right, with their cross ($\frac{65}{4}$) between them.

cross is near that of the large inflated parent. While the fruits of the cross are with two placentæ and long taper-pointed, as in "Red Hot," they are unlike it in being greatly inflated for their whole length, thus giving a large air space and making the thick lance-shaped fruits peculiarly bladdery. In breadth (at base) the cross is 45 mm., and thereby illustrates that the compact-fruited parent has a greater potency than the greatly inflated "Spanish." Concerning length there is a good illustration here of the fruit of the cross being longer than that of either parent, for the mother is 90 mm.; the father, 88 mm.; and the offspring, 110 mm., unless the true measure of the length of a fruit with a depressed tip should include the whole distance upon the outside of the fruit over the so-called tip and down into the depression to the point where the base of the style was located, in which case the ratio would be different.

"Squash-Coral Gem" (28/11). This cross is shown in the middle of the upper half of Plate XVI., with the "Squash" (28) or pollen parent upon the left, and the mother, "Coral Gem" (11), upon the right. The contrast is great in the fruits of the two parents—the shape of the "Squash," as the name suggests, is broad and flat, the length not being more than a half of the width, and the thick wall is more or less ribbed. The "Coral Gem" has small, slender-stemmed, nearly straight, short, spindle-shaped, thin-walled fruits, well shown in the plate.

The group of cross-fruits shows that a heart-shape prevails, that is, the "Squash" has had remarkable power in developing the breadth of base, while at the same time the tip has been carried up quite beyond that of either parent; in other words, while the breadth is a fair average between that of the two parents, the factor for length has acted differently and demonstrates that there is some relationship maintained between the length and breadth as these factors act in combination. It may be that the factor for length lies dormant or under restraint in the "Squash," and this is permitted to have freedom of action when the combination is made with a type like the long-oval of the "Coral Gem."

The interior of the fruit offers some points of contrast, for the "Squash" has a thick dry flesh, while the interior of the "Gem" is a wet pulp. Of ten fruits of the cross from the same plant examined all were two-celled like the "Gem," eight had thick dry flesh, and two were with thin wall with a wet pulp within. There were also some differences in the shade of red and the form of the calyx. There were noticeable differences in the size of the seeds in different fruits; those with soft pulp, for example, being smaller and more like those of No. 11.

"Ruby Pearl-Bird's Eye." The fruits of this cross are shown in the middle of the lower half of Plate XVI., with its pollen parent upon the left (65), and the mother (4) upon the right. Both parents have fruits with the length exceeding the breadth and the ratio is maintained in the cross. In weights, a fair index of size in this case, the range is per fruit 19 grams for the "Pearl," .4 for the "Bird's Eye" and 1.4 for the cross; that is, while the form of the cross is a fair average of the two parents, in weight, the "Bird's Eye" has a controlling influence. In like manner the seed-cavities of the crossed fruits are usually two as in the mother, and not three as ordinarily prevails in the "Pearl." In size of seed, the fruits from a crossed plant show considerable range, some approaching the large size of the "Pearl," while others are nearly as small as the "Bird's Eye."

Variations in Pepper Fruits Upon the Same Plant.

As a rule, the smaller-fruited sorts of peppers have considerable uniformity in their fruits, and the smaller the kind the greater the uniformity; but even here there seems to be less conformity to a definite type than in eggplants, tomatoes and other vegetable fruits. This may be due in large part to the thin yielding fruit-wall and the great effect upon form due to the number of locules, and that these seed-cavities are rarely constant excepting in the small fruits or those that are long and slender, in which they are usually two.

It is, therefore, among the large-fruited sorts that great variations are found. One of these commercial varieties has taken upon this account in part, probably, the name of "Monstrous," and as its low record number (16) shows, it was among the sorts first introduced to the experiment grounds.

As an illustration of the diverse sizes and shapes of the "Monstrous" fruits, Plate XVII. is introduced, all specimens being from one plant. The upper row of fruits, from 1 to 8, are all mature, and it is apparent that no two are much alike. At 9 and 10 are shown a three and four-lobed tip, respectively, while

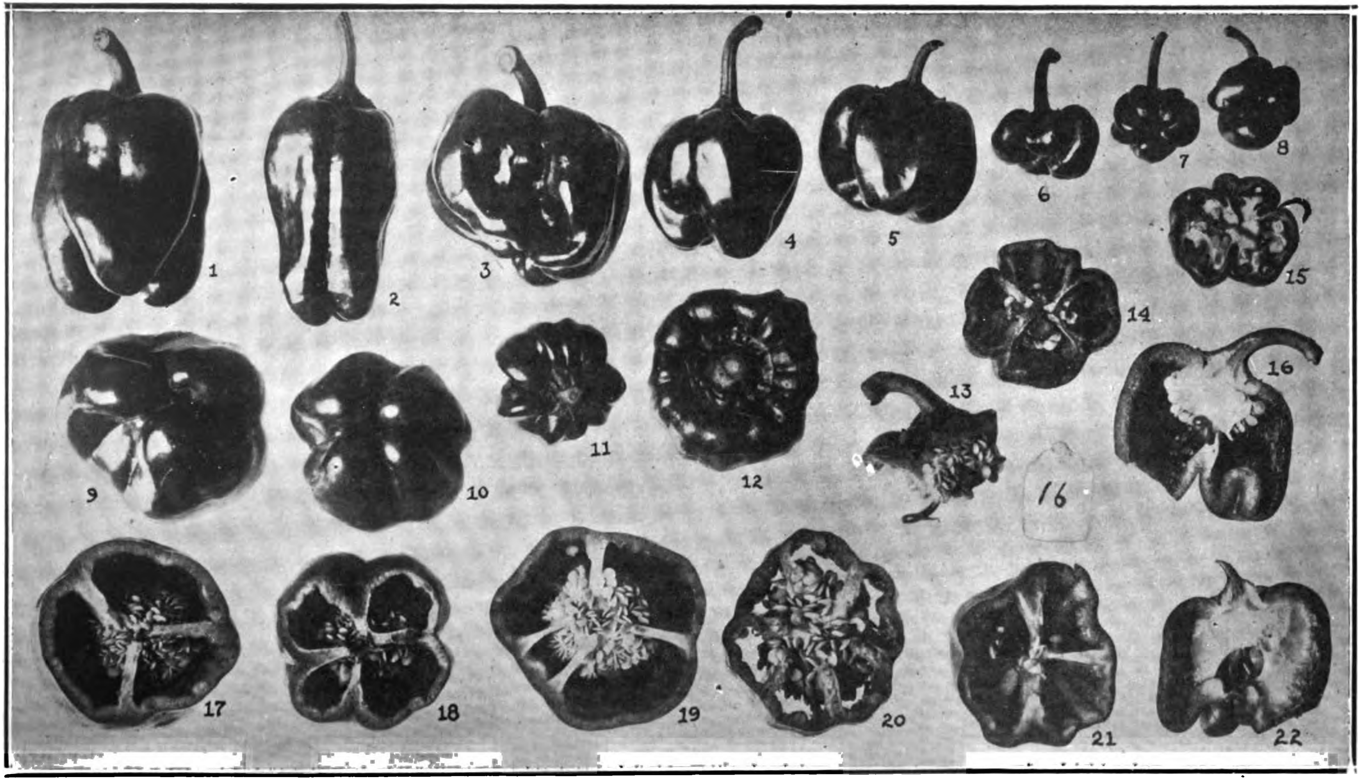

PLATE XVII.

Pepper Fruits. The great variability of the size and shape of pepper fruits is shown in the case of the "Monstrous" (16), where samples are given whole and sectioned from the same plant.

at 11 and 12 are presented the calyx end of two others that differ widely at the base. The lower row, 17 to 20, shows interior views in which the partition walls vary from three to six, and the lack of seeds is shown at 21 and 22, the latter presenting an interior that is well filled with secondary pistils in place of seeds.

"Malformation" in Pepper Fruits.

The "Prizetaker" (43) is a variety with large, broad, deeply lobed, thin-walled, pendent fruits with from three to six locules and a strong tendency to produce one-sided fruits which in general result from one-quarter or a third failing to enlarge normally. A study of the normal fruits shows that the large seed-bearing cone is uniform upon all sides, and the seeds are evenly distributed over it, and there is nothing unusual in any way apparent. When the unsymmetrical fruits are cut midway of the placentæ so as to open out the parts, it is found that there are two modifications from the normal. In the first place, the seeds are much reduced upon the portions that have developed the least. Frequently there are no seeds upon the side where growth has been restrained; and if the fruit is dwarfed upon all sides, there may be only a very few seeds upon the placentæ opposite the greater development of wall. When a young fruit is similarly dissected, the ovules are observed in nearly equal numbers upon all portions of the placental cone; but they fail to develop, due, it is inferred, to lack of vigor, possibly to a failure of pollen to reach that locality, as is shown by the dark specks that represent the ovules in the maturing fruit.

There is possibly another cause for the abnormal shape of pepper fruits, as is abundantly illustrated in the same variety above considered. For example, there are many fruits that are seedless, and while usually under size, they may be well balanced. But, upon the other hand, the seedless fruits may be very misshapen and uniformly there is a development of secondary pistils upon the side that has been checked in its growth. In some instances the restrained side of the fruit is packed to its utmost with these internal fruits, some of them carrying the rich red of the normal ripe fruits, and interspersed with those of the contrasting green of the immature specimens. It seems that the mother fruit does not respond similarly to this load of young pistils as to that of forming seeds, but instead the nourishment that might go to the formation of wall tissue is used up in feeding the crowding structures within.

The "Elephant's Trunk" (13) is a long slender-fruited variety that well illustrates the contortions that may be found in peppers, and Plate XVIII. shows a group of specimens of this sort gathered late in the season from a single plant and exhibiting many ages from the long scythe-shaped mature fruit at 1 to the flower buds at 10. In these long fruits the seeds are not numerous and are borne chiefly near the base with an occasional one above, often widely separated, as shown at 2, 5, 19 and 21. The amount of twisting may be so great as to result in a close coil, as shown at 8, the interior of the same fruit being given at 15. A more common form is that of a ram's horn, as illustrated at 4, where the curve is large and did not admit of a longitudinal section being given satisfactorily. Only the small, yet mature, fruits are nearly seedless, such a one being given at 18. The branch at 9 shows how adjoining fruits may be quite different when still quite young. It may be possible to determine what effect the seed formation has upon the contortions of the fruits that bear them. Shaped as this sort is, it seems likely that but a small internal force may determine the form that the long fruit may assume.

A Study of Wrinkled Pepper Fruits.

The majority of the larger commercial peppers are with a rough surface; that is, the seed cavities have been increased to three, four or more, and a depressed tip and ribbed sides have accompanied this change in the seed-bearing surface. There are, however, certain sorts that are especially misshapen; and of these, two sets are shown in Plate XIX. The upper double row ("Scallop," 32) shows a series of fruits from those just after the blossoms had fallen, seen at the left, to the fully mature fruits upon the right. A half of each fruit, showing the exterior, is given in the upper row; and a section of the same fruit is shown directly below. At the outset the fruit is oval and very little ribbed, but very soon the wall develops rapidly near the middle and brings about a form that bears a strong resemblance to the scalloped or patty-pan squash. Peppers that develop into the scalloped form are thin-walled, having a comparatively large air cavity, and produce but few seeds.

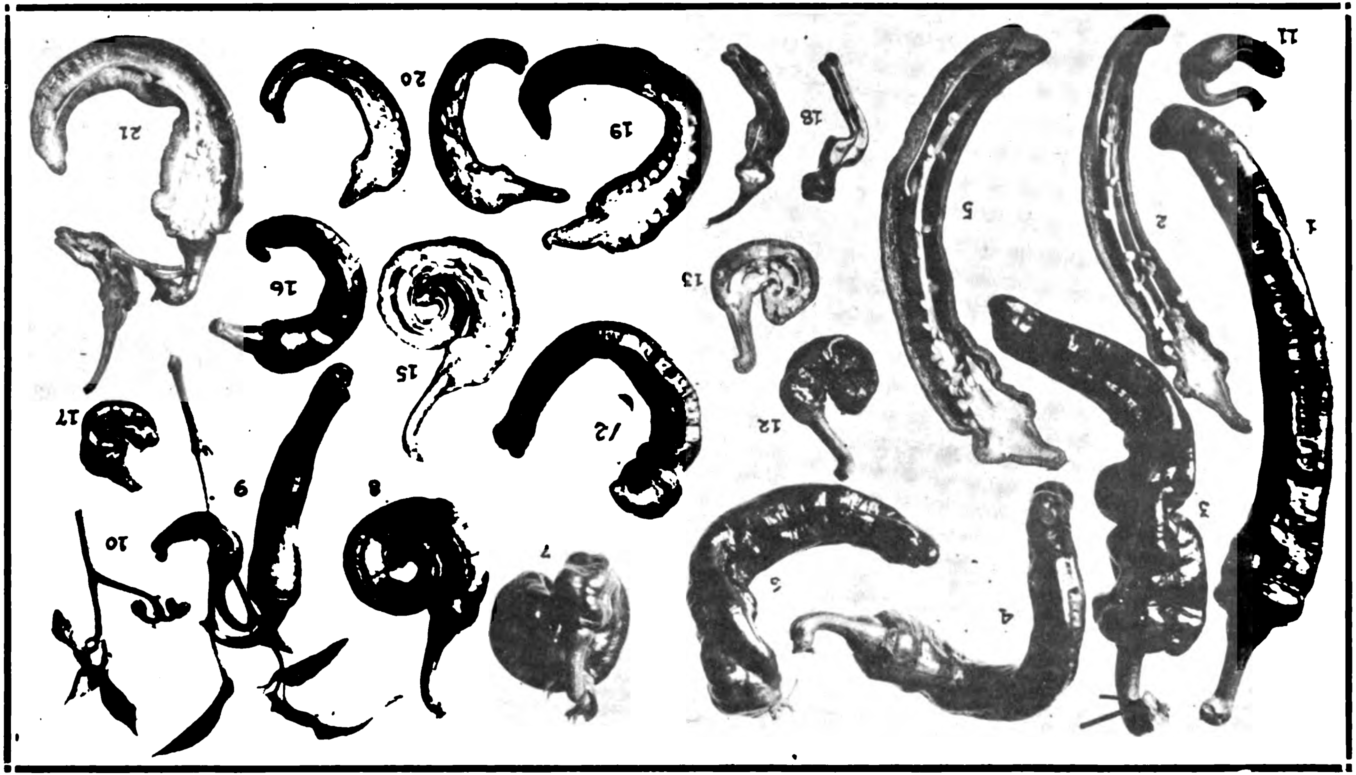

PLATE XVIII.

Pepper Fruits. Fruits from a single plant of "Elephant's Trunk" (18) showing some of the possible contortions that may take place in pepper fruits of the long type.

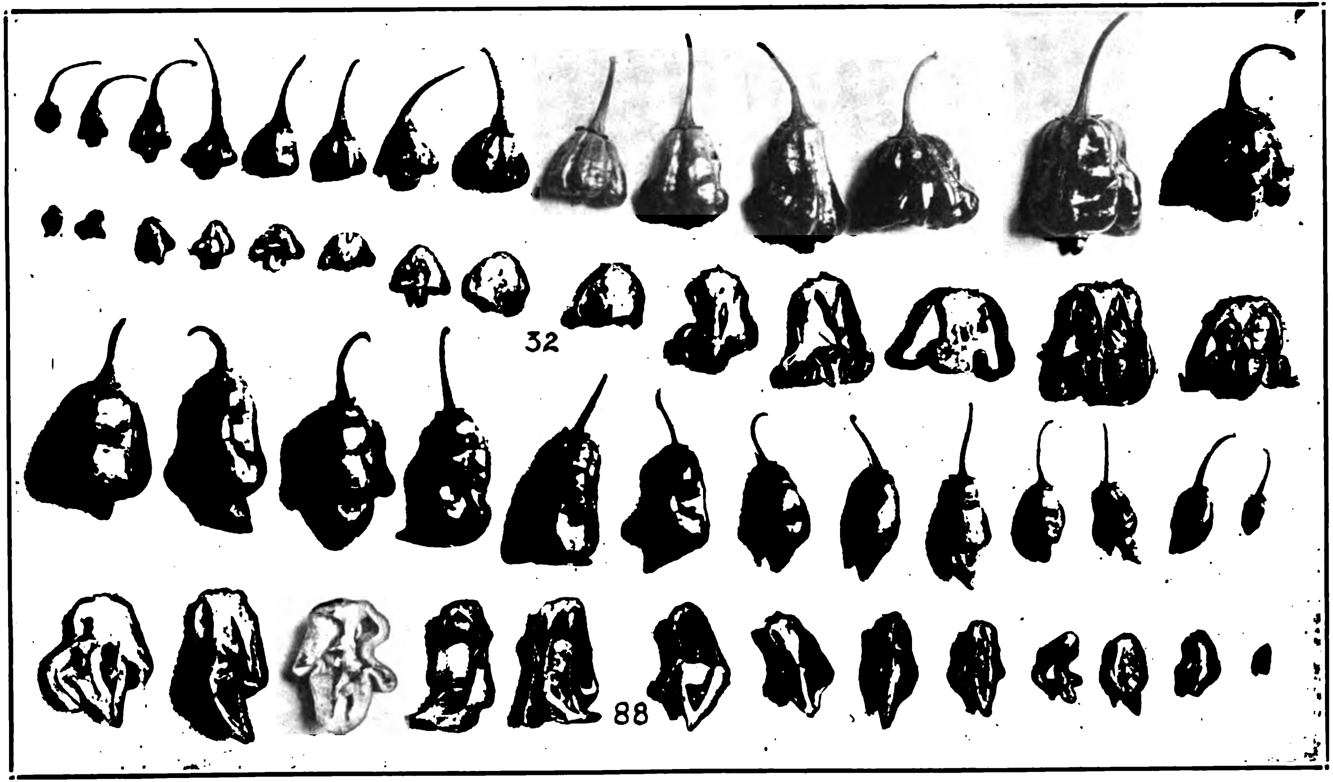

PLATE XIX.

Pepper Fruits. Two kinds of strangely-shaped peppers are shown: the so-called "Scallop" pepper (32) in the upper half in a series from the very young to the mature fruit with a longitudinal section of each fruit shown below. A similar set of "Wrinkled" (88) is shown in the lower half, the sequence running from right to left.

In the lower half of the plate is a corresponding set of the variety named "Wrinkled Pepper" (88), with the ages reversed to better fill the space. In other words, beginning at the right are shown the young fruits in surface view in the upper of the two rows, and the interior shown for the same fruit directly below. Here again the young fruits are not far from the normal form, but quickly a bulging begins near the middle resulting in the scallop (shown in the folds of the wall in the sections of the older fruits), as if by pressure the point had been held stationary while the side wall, as it grew, was forced to fold back upon itself. The cause of the unusual form lies, however, within the fruit, and the result is far from uniform, the folds varying in depth and frequently are upon one side when the fruit-tip is thrown out at right angles to the main axis.

The following table gives some of the facts concerning these wrinkled fruits when mature:

"Scallop" A.	10	fruits	weighed 32 grams.	
" "	10	"	measured 48 cc.; specific gravity	66.66
" B.	10	"	weighed 40 grams.	
" "	10	"	measured 57 cc.; specific gravity	70.17

It is seen that the fruits are small, that their weight is near two-thirds that of water, while the flesh is as heavy as that of ordinary peppers.

Ten other fruits (large), weighing 47 grams, yielded seeds as follows: 11, 3, 8, 36, 20, 24, 26, 13, 19, 14; total, 174. Ten small fruits from the same plant as those above and weighing only 28 grams, gave seeds, respectively, 8, 1, 11, 5, 13, 0, 0, 18, 8, 8; total, 72. So far as it goes, this study indicates that size of fruit, within the same plant, at least, is associated with the number of seeds; that is, the larger the number of seeds, the larger the fruit. It is probable that much of the variation in the size of pepper fruits upon any given plant is to be attributed to the measure of fecundation that has taken place.

In the pepper is a kind of fruit that can be developed to considerable size, marketable for that matter, without bearing any seeds. Thus, two of the wrinkled ones above tabulated contained no seeds, and one other only one, and one of the large group had but three. It is possible that this factor may need to be constantly reckoned with in the study of size and shape of pepper fruits.

A Study of the Wall of Pepper Fruits.

The pepper fruit-wall is remarkably variable; in some varieties it is very thin, almost a mere skin, within which the pulp and seeds are borne. As is to be expected, there is some correlation between the size of the fruit and the thickness of the wall. In other words, one seeks for the thinnest wall in the small-fruited sorts that are in this regard nearest to the condition of the wild state. On the other hand, the fleshy wall is to be sought for among the large-fruited kinds and with a smooth exterior. A fruit may be of the largest bulk and yet have a thin wall, but such are very flabby, deeply ribbed and usually with the tip depressed.

In Plate XX. the sections of fruits are arranged in two series, namely: (1) the thin group, extending from the upper left-hand corner (94) along the top of the engraving and ending in 2 of the second row. In like manner (2) the sections illustrating the thick-walled series start with 119, and with the size of fruit increasing as in the first series, fill up the remaining portion of the plate, ending with the large section at 134, the accompanying numbers being those associated with the commercial names of the several varieties represented.

If No. 2, "Large Bell," is contrasted with No. 134, "Sweet Spanish," it is seen that they differ in many things aside from the thickness of the wall, which last needs no words to bring out the contrast. No. 2 is from a deeply-lobed fruit that, upon reaching maturity, soon becomes flabby and, as a rule, rapidly deteriorates from attacks of fungi or mere evaporation. The seed-core is small and early becomes pithy, and the great bulk of the fruit is air space, the whole riding high upon water when placed in that liquid. In striking contrast with these factors is the seed-bearing center in 134, which occupies a large percentage of the interior to which the thick wall is held by substantial partitions—in this case, four at equidistant intervals. Fruits of this type are heavy, hold their form and preserve a smooth surface for a long time.

Should a medium size be contrasted in the two series as, for example, Nos. 85 and 121, practically the same is true as stated above for the largest fruits. The former is a bulky, light-weighted fruit, while the latter is firm of flesh, a good keeper, and for many purposes much superior to the thin-walled type.

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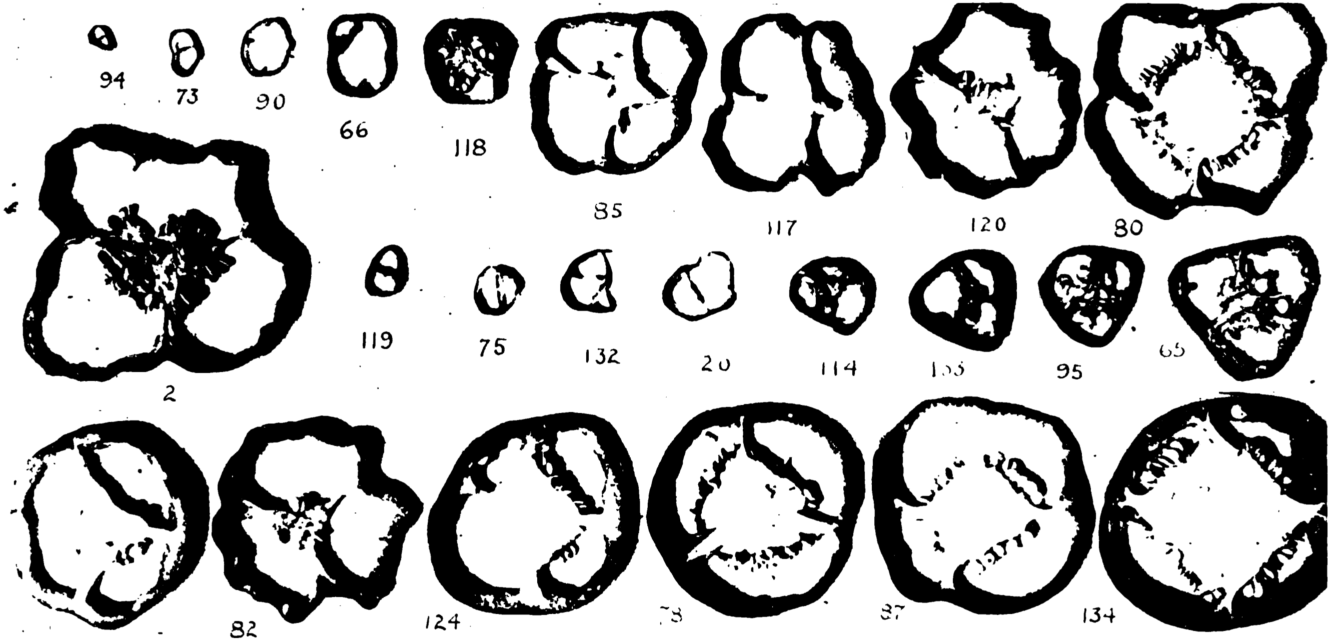

PLATE XX.

Pepper Fruit Wall. A series of sections of thin-walled peppers is shown from No. 94 to No. 2, and of a thicker-walled series from No. 119 to No. 134.

As before stated, the small-fruited wild type is more of the structure of a thin-walled juicy berry with the seeds immersed in a watery pulp. Among these there are those in which the wall has lost the thinness of paper and developed a fleshiness which for the size of the fruit is quite comparable with the wall of the kinds shown at 124 and 134. In other words, thickness of the wall is a somewhat relative term, but actual substantial fleshiness in the commercial sense is perhaps not as yet met with in the small fruits. In other words, a wall that is three times the thickness of an exceedingly thin one is still thin; but with increasing size of the fruit, it may become by culture or breeding a well-developed thick-walled variety.

TABLE OF PEPPER FRUITS GROWN IN 1910.

Record number.	Plant number.	Number of ripe fruits.	Number of green fruits.	Total number of fruits.	Locules					
					1	2	3	4	5	6
1/6	1	29	57	86	...	47	37	2	...	...
1/36	2	73	90	163	...	67	92	4	...	...
1/36	3	122	28	150	...	70	78	2	...	...
1/36	8	9	6	15	...	12	3	...	...	...
1/36	10	99	121	220	...	161	58	...	1	...
2/20	2	10	134	144	...	35	103	4	2	...
2/25	2	8	41	49	...	4	25	19	1	...
5/9	1	40	56	96	...	65	31	...	...	...
5/9	3	125	167	292	...	57	235	...	...	...
5/11	1	46	71	117	...	67	48	2	...	...
5/11	4	18	106	124	...	87	35	2	...	...
5/11	16	29	110	139	...	67	69	3	...	...
5/11	17	119	331	450	...	406	43	1	...	...
5/11	20	63	49	112	...	27	75	10	...	...
5/11	21	62	131	193	...	10	139	42	...	2
5/11	44	78	85	163	...	74	86	3	...	...
5/15	3	4	100	104	...	2	83	19	...	...
5/15	4	5	36	41	...	1	26	14	...	...
5/15	7	9	75	84	...	2	36	35	5	6
9/42	2	62	249	311	...	263	48	...	...	...
10/18	1	12	80	92	...	6	72	14	...	...
10/18	6	14	58	72	...	29	40	3	...	...
11/21	1	95	122	217	...	52	159	6	...	...
11/21	1½	67	26	93	...	59	31	3	...	...
11/21	1¾	49	211	260	...	153	107	...	...	...
11/21	2	80	60	140	...	105	35	...	...	...
11/21	3	20	60	80	...	72	8	...	...	...
11/21	3½	207	399	606	...	535	71	...	...	...
11/21	9	49	6	55	...	49	6	...	...	...
17/6	1	26	32	58	...	8	34	15	1	...
17/6	3	64	153	217	...	134	82	1	...	...
17/9	1	44	63	107	...	42	64	1	...	...
17/9	2	20	71	91	...	54	37	..	...	...
17/9	2½	76	340	416	...	368	48	...	...	...
17/5	7	81	245	326	2	193	131	...	...	...
18/6	1	44	64	108	...	69	38	1	...	...
18/7	1	67	58	125	...	47	78	...	...	...
18/7	2	44	207	251	...	152	93	5	1	...
18/10	1	9	70	79	...	43	34	1	1	...
18/21	1	97	169	266	...	257	9	...	...	...
18/21	6	152	128	280	...	268	12	...	...	...
21/38	2	101	87	188	...	161	27	...	...	...
21/45	4	135	282	417	...	271	139	7	...	...
21/47	1	865	634	1,499	...	1,429	70	...	...	...
26/21	1	19	153	172	...	160	12	...	...	...
26/21	3	15	14	29	...	9	18	2	...	...
26/21	4	36	13	49	...	40	6	2	1	...
26/21	6	73	219	292	3	269	20	...	...	...
26/21	8	57	57	114	...	53	58	3	...	...
26/21	9	18	10	28	...	17	11	...	...	...
26/21	9½	2	42	44	...	...	29	14	1	...
26/21	16	50	53	103	...	30	71	2	...	...
26/21	20	24	50	74	...	49	25	...	...	...

TABLE OF PEPPER FRUITS GROWN IN 1910.

The following table does not call for introductory words; it gives facts concerning fruit numbers for many varieties and crosses:

Record number.	Plant number.	Number of ripe fruits.	Number of green fruits.	Total number of fruits.	Locules					
					1	2	3	4	5	6
2	...	3	19	22	...	2	15	5	...	...
4	...	...	258	258	1	209	48	...	...	...
8	...	19	180	199	...	186	13	...	...	...
9	...	39	76	115	...	98	15	2	...	...
10	...	...	12	12	...	...	3	9	...	...
11	...	40	48	88	...	86	2	...	...	...
12	...	4	43	47	...	3	36	8	...	...
13	...	1	17	18	...	...	14	4	...	...
14	...	5	15	20	...	6	12	2	...	...
15	...	...	14	14	...	...	6	8	...	...
19	...	3	7	10	...	1	6	3	...	...
20	...	33	90	123	...	81	41	1	...	...
23	...	2	13	15	...	...	11	4	...	...
24	...	2	22	24	...	...	12	12	...	...
25	...	1	11	12	...	...	4	7	1	...
26	...	2	33	35	...	10	23	2	...	...
27	...	1	18	19	...	...	14	5	...	...
34	...	27	205	232	...	44	169	19	...	...
46	...	11	170	181	...	37	125	18	1	...
48	...	7	26	33	...	8	23	2	...	...
65	...	5	52	57	...	5	44	8	...	...
66	...	27	75	102	...	77	25	...	...	...
67	...	50	222	272	...	212	59	1	...	...
70	...	7	14	21	...	5	13	3	...	...
71	...	10	75	85	...	53	32	...	...	...
72	...	24	299	323	...	192	131	...	...	...
73	...	5	63	68	...	43	25	...	...	...
74	...	...	89	89	...	20	19	...	...	...
75	...	3	492	495	...	411	82	2	...	...
76	...	...	40	40	...	13	25	2	...	...
78	...	8	16	24	...	6	9	7	...	2
79	...	3	63	66	...	1	13	44	8	...
81	...	5	67	72	...	4	55	13	...	...
82	...	7	34	41	...	2	30	8	...	1
28/11	2	118	210	328	...	233	93	2	...	...
28/11	2½	182	179	361	...	170	174	12	5	...
28/11	5	84	8	92	...	47	43	2	...	...
28/11	9	67	75	142	...	35	100	5	2	...
28/20	3	46	180	226	1	121	96	8	...	...
28/20	3½	46	125	171	...	117	52	2	...	...
28/20	6	57	43	100	...	35	62	3	...	...
28/20	14	21	200	221	...	117	93	11	...	...
31/9	1	23	51	74	...	...	20	54	...	...
36/20	2	147	36	183	...	178	5	...	...	...
36/20	2⅓	270	342	612	1	533	75	3	...	...
36/20	2⅔	126	98	224	...	201	23	...	...	...
36/20	3	254	213	467	1	360	105	1	...	...
36/20	5	56	34	90	...	69	21	...	...	...
37/5	1	9	81	90	...	10	59	19	1	1
37/7	3	24	303	327	...	84	214	26	2	1
37/47	2	5	73	78	...	21	45	9	3	...
37/47	3	10	124	134	...	49	78	6	1	...
38/11	1	19	4	23	...	9	14	...	...	...
38/11	2	12	99	111	...	11	84	16	...	...
38/11	3	20	27	47	...	29	18	...	...	...
40/12	3	44	14	58	...	28	30	...	...	...
40/12	4	6	53	59	...	15	43	1	...	...
41/11	3	56	190	246	...	200	43	3	...	...
42/9	1	...	251	251	1	228	22	...	...	...
42/26	1	45	40	85	...	56	27	2	...	...
47/7	2	534	803	1,337	...	990	345	2	...	...
47/37	1	11	413	424	...	118	286	19	1	...
48/15	1	15	92	107	...	14	82	11	...	...
48/15	3	27	114	141	...	35	94	12	...	...
48/15	5	42	74	116	...	33	74	9	...	...
48/20	3	21	243	264	...	141	114	8	...	1
48/36	1	35	13	48	...	21	26	1	...	...
48/36	2	111	69	180	...	156	23	1	...	...
48/36	2⅓	77	106	183	...	165	18	...	...	...
56/47	2	195	199	394	...	328	66	...	...	...

TABLE OF PEPPER FRUITS GROWN IN 1911.

Record number.	Plant number.	Number of ripe fruits.	Number of green fruits.	Total number of fruits.	Locules.							
					Ripe fruits.				Green fruits.			
					2	3	4	5	2	3	4	5
7	2	53	90	143	35	18	...	...	58	32	...	...
8	5	133	...	133	95	38	...	...	...	...	...	...
9	5	130	126	256	125	5	...	...	111	15	...	...
14	8	24	25	49	...	19	5	...	...	23	2	...
14	9	24	15	39	1	11	12	...	2	11	2	...
14	12	20	19	39	2	14	4	...	5	11	3	...
17	2	29	...	29	1	18	10	...	...	...	...	...
20	11	163	133	296	85	70	8	...	65	68	...	...
20	14	87	290	377	41	45	1	...	177	110	3	...
22	1	160	...	160	160	...	...	...	...	...	...	...
27	5	19	...	19	...	9	9	1	...	...	...	...
43	5	24	24	48	6	13	5	...	6	15	3	...
65	2	22	...	22	3	11	8	...	...	...	...	...
65	9	60	...	60	...	20	35	5	...	...	...	...
65	12	20	36	56	4	13	3	...	4	25	7	...
66	10	58	38	96	50	8	...	...	31	7	...	...
68	8	26	16	42	5	19	2	...	9	7	...	...
69	4	78	...	78	64	13	1	...	...	...	...	...
71	5	131	...	131	72	59	...	...	...	...	...	...
76	2	40	25	65	38	2	...	...	25	...	...	...
80	8	6	15	21	1	4	1	...	1	13	1	...
81	4	11	38	49	...	3	8	...	...	27	11	...
81	11	13	49	62	...	9	4	...	4	39	6	...
81	13	18	22	40	...	14	4	...	2	18	2	...
84	...	...	178	178	...	...	...	...	142	36	...	...
85	...	2	20	22	...	2	...	...	1	14	5	...
86	...	1	29	30	...	1	...	...	4	17	8	...
87	...	1	79	80	...	1	...	...	...	37	40	2
87	...	3	18	21	...	...	2	1	...	12	6	...
90	4	15	250	265	15	...	...	...	250	...	...	...
90	...	...	250	250	...	...	...	...	240	8	2	...
92	...	...	93	93	...	...	...	...	...	69	23	1
93	...	1	94	95	...	1	...	...	5	74	15	...
94	...	90	504	594	87	3	...	...	484	20	...	...
95	8	78	...	78	41	29	8	...	...	...	...	...
95	...	23	75	98	7	13	3	...	26	46	3	...
102	...	26	83	109	3	17	6	...	9	58	15	1
103	8	158	43	201	132	26	...	...	43	...	...	...
103	...	33	160	193	26	7	...	...	146	14	...	...
105	4	330	85	415	315	15	...	...	85	...	...	...
105	...	29	352	381	28	1	...	...	330	22	...	...
106	...	68	505	573	60	8	...	...	442	62	1	...
107	8	82	95	177	16	56	10	...	46	48	1	...
107	...	12	152	164	1	9	2	...	42	99	11	...
110	...	4	20	24	3	...	1	...	7	9	4	...
111	...	5	39	44	1	4	...	...	6	23	10	...
112	...	35	348	383	19	16	...	...	231	116	1	...
115	...	3	19	22	...	2	1	...	...	12	7	...
116	...	19	57	76	2	11	6	...	9	38	10	...
120	...	...	11	11	...	...	...	...	1	6	4	...
122	8	15	15	30	1	6	8	...	3	8	4	...
122	...	2	37	39	...	1	1	...	1	21	14	1
123	...	4	17	21	...	4	...	...	6	10	1	...
124	...	4	26	30	...	1	3	...	..	18	8	...
126	...	28	19	47	8	16	4	...	...	10	9	...
129	...	...	26	26	...	...	...	...	15	9	2	...
133	...	39	55	94	6	29	4	...	18	35	2	...
134	...	2	...	...	...	1	1	...	...	...	...	...
2/20	4	83	...	83	9	49	25	...	...	...	...	...
2/20	5	68	...	68	19	43	6	...	...	...	...	...
2/20	9	109	...	109	31	73	5	...	...	...	...	...
2/20	10	98	...	98	49	49	...	...	...	...	...	...
2/20	15	63	...	63	27	35	1	...	...	...	...	...
17/9	4	79	36	115	59	20	...	...	23	13	...	...
17/9	7	43	51	94	40	3	...	...	43	8	...	...
17/9	8	62	108	170	48	13	1	...	80	27	1	...
17/9	10	44	91	135	41	3	...	...	75	16	...	...
12/45	4	40	106	146	19	21	...	...	41	63	2	...
21/45	6	101	...	101	87	14	...	...	...	...	...	...
21/45	8	15	6	21	5	10	...	...	3	3	...	...
21/45	12	131	169	300	122	9	...	...	121	46	1	1
21/45	14	184	...	184	164	20	...	...	...	...	...	...

TABLE OF PEPPER FRUITS GROWN IN 1911—*Continued.*

Record number.	Plant number.	Number of ripe fruits.	Number of green fruits.	Total number of fruits.	Locules. Ripe fruits. 2	3	4	5	Green fruits. 2	3	4	5
21/45	23	152	...	152	121	31	...	...	...	...	...	...
21/45	24	79	...	79	49	29	1	...	...	...	...	...
21/45	26	61	90	151	33	28	...	...	36	53	1	...
23/11	2	89	62	101	88	1	...	...	60	2	...	...
23/11	3	107	...	107	90	17	...	...	...	...	...	...
23/11	7	17	13	30	12	5	...	...	8	5	...	...
23/11	10	119	...	119	81	38	...	...	...	...	...	...
23/11	13	13	...	13	7	5	1	...	...	...	...	...
23/11	15	37	...	37	37	...	...	...	...	...	...	...
23/20	4	98	...	98	20	71	7	...	...	...	...	...
23/20	6	106	...	106	61	44	1	...	...	...	...	...
23/20	10	125	...	125	50	75	...	...	...	...	...	...
23/20	12	124	...	124	52	64	8	...	...	...	...	...
23/20	13	148	...	148	88	58	2	...	...	...	...	...
23/20	14	156	...	156	119	36	1	...	...	...	...	...
23/20	15	108	108	216	66	40	2	...	45	59	4	...
46/67	1	92	...	92	80	12	...	...	...	...	...	...
46/67	2	86	...	86	72	14	...	...	...	...	...	...
46/67	5	222	...	222	222	...	...	...	...	...	...	...
48/20	1	14	63	77	8	6	...	...	35	28	...	...
48/20	2	50	71	121	20	29	1	...	21	50	...	...
48/20	3	82	...	82	33	46	3	...	...	...	...	...
48/20	4	40	90	130	8	32	...	...	20	66	4	...
48/20	5	56	64	120	31	25	...	...	27	37	...	...
48/20	7	159	...	159	94	56	9	...	...	...	...	...
48/20	8	18	58	76	6	11	1	...	28	30	...	...
48/20	11	69	...	69	32	37	...	...	...	...	...	...
48/20	12	82	...	82	19	62	1	...	...	...	...	...
48/20	13	111	...	111	61	50	...	...	...	...	...	...
48/20	14	38	54	92	12	25	1	...	21	33	...	...
65/4	5	751	19	770	751	...	...	...	19	...	...	...
65/4	6	715	...	715	485	230	...	...	...	...	...	...
65/4	8	419	189	608	244	175	...	...	125	64	...	...
65/4	12	560	155	715	525	35	...	...	145	10	...	...

The reader may gather from the above table that there is a great range in the number of fruits per plant. The ratio between the ripe and green fruits is of little value because the harvest was continued over a long period during both years. It is seen that the great majority of the fruits are with two or three locules.

The Breeding of Peppers.

As breeding is one of the leading methods of putting questions to living things concerning their factors of heredity, it may not be amiss to illustrate how a project in this line of work may be planned. It is prefaced that a previous knowledge of the inheritance of qualities in animals or in other plants is sufficient to enable the breeder to feel reasonably assured that among peppers, for example, the factors of fruit position, fruit color and fruit flavor are possible pairs, and that one of each pair is more potent than the other. For example, the factor of pendency may be stronger than that of uprightness of fruit; that red dominates orange; and pungency that of its absence, namely sweetness.

The general reader of the report may find it an advantage to study the accompanying plan made for the breeding together of two kinds of peppers that represent the six unit characters, or una, above named. Thus if a plant having any three is bred with another carrying the other three una, the combinations possible in the second generation are as shown in the chart. The stronger or dominant unum in each pair is represented by a capital initial, while the one that is hid from sight, when the dominant is present, that is, the latent or recessive one, takes the small initial. Thus P, R and H are assumed as the dominant, and u, o and s the recessive una.

BREEDING UNA IN PEPPERS.

	PRH	uRH	PRs	uRs	PoH	uoH	Pos	uos
PRH	PRH PRH	uRH PRH	PRs PRH	uRs PRH	PoH PRH	uoH PRH	Pos PRH	uos PRH
uRH	PRH uRH	uRH uRH	PRs uRH	uRs uRH	PoH uRH	uoH uRH	Pos uRH	uos uRH
PRs	PRH PRs	uRH PRs	PRs PRs	uRs PRs	PoH PRs	uoH PRs	Pos PRs	uos PRs
uRs	PRH uRs	uRH uRs	PRs uRs	uRs uRs	PoH uRs	uoH uRs	Pos uRs	uos uRs
PoH	PRH PoH	uRH PoH	PRs PoH	uRs PoH	PoH PoH	uoH PoH	Pos PoH	uos PoH
uoH	PRH uoH	uRH uoH	PRs uoH	uRs uoH	PoH uoH	uoH uoH	Pos uoH	uos uoH
Pos	PRH Pos	uRH Pos	PRs Pos	uRs Pos	PoH Pos	uoH Pos	Pos Pos	uos Pos
uos	PRH uos	uRH uos	PRs uos	uRs uos	PoH uos	uoH uos	Pos uos	uos uos

P=pendent R=red H=hot
u=upright o=orange s=sweet

Let the breeding be done and as a result the first offspring theoretically, that is, according to Mendel's law, all show the three dominant una, namely, pendent, red, hot fruits, with no indications of uprightness, orange color, or sweetness.

When these first generation (F_1) plants are grown among themselves, all foreign crossing being strictly prohibited by isolation of the plot of plants (or through hand-working of the flowers), there will be a mingling of the six una, as illustrated in the chart. The upper row, for example, shows the several types of pollen grains produced so far as the qualities in question are concerned, and upon the left side are given the same combinations obtaining with the egg-cells of the unformed seeds. The possible combinations of the male and female germs—they, it being presumed, are produced in the same ratio—are given in the sixty-four rectangles, the qualities carried by the pollen in each case being placed as the numerator and the egg-cell as the denominator of the sixty-four fractions.

In the actual work of the field, it is evident that one needs to have at least sixty-four plants in the second generation (F_2), and better still a great many more in order to secure fair representation of the possible combinations. For example, the sixty-four plants as represented in the plan include but one that contains only the dominant una, namely, P, R, H, as derived from both its parents; and this is the one in the first square as shown in the upper left-hand corner, and such a plant, if grown isolated, would have only pure dominants for all time. In like manner, there is but one plant that has only the recessive una as given at the opposite corner, and here again all offspring under strict isolation would have upright, orange, sweet fruits. All of the combinations that are situated in the diagonal between the two corner squares just considered are likewise pure, as it is termed; that is, will, when grown by themselves, repeat the same combination without any cropping out of a hidden unum. Thus, $\frac{uRH}{uRH}$ can produce only upright, red, hot fruits, because the pendent unum is entirely absent and cannot therefore exert its dominant influence in this case over the recessive upright unum. Again, in the same diagonal line and near the middle of the chart, there is $\frac{uRs}{uRs}$; that is, there is only one unum of each pair present, and therefore the plant must breed true to its kind unless foreign pollen, bearing another representation of the pairs, is introduced.

Space will not permit of further noting of details of the plan, but with a block of plants sufficiently large to insure all of the possible combinations being present, the breeder with this scheme for three pairs of una before him has a subject for investigation that may well command a large amount of time and give scope for critical study.

The hypocotyl in dicotyledonous plants,—and the present study is confined to this great group of flowering plants,—is that portion of the initial stem that is located between the root system and the stem system of the plant. In other words, at one end, usually the lower, the hypocotyl is blended with the main root in what is known as the juncture, and at the upper extremity it bears the two seed-leaves and the plumule, that is, the seed bud that unfolds into the true stem and leaves. This hypocotyl may be very long in some species, as the buckwheat, and reduced near to zero in others, as the pea and a large number of plants with the general characteristic of the cotyledons remaining below ground in germination.

While it is presumed that in the same species the length of the hypocotyl is somewhat uniform, it is valuable as a basis for later research to determine the range of variation and the conditions that most influence its length. Therefore, the present preliminary study falls under a sub-project that may be defined as that of Environmental Influence upon Length of Hypocotyl, and leads up to a study of the capacity of plants to perpetuate their individual peculiarity of length of the seed-stem. With both these phases of the work in mind, at the outset, it was necessary to cast about for subjects that would lend themselves well to the research proposed.

A suitable subject needs to have a hypocotyl of (1) considerable length, for convenient measurement; (2) rapid growth to economize time; (3) medium size to economize space; and the plant, other things being equal, (4) should be self-fertile to save the labor of hand-pollination; and (5) produce a large number of strong viable seeds that (6) are of a convenient size to handle.

The reader quickly sees that large, slow-growing, tree seeds, as the various nuts, would be unsuitable upon the one hand, and the great mass of small-seeded species, as tobacco, the mustards and their like, would be excluded upon the other.

After a general survey, the list for use was narrowed down to the following few: soy bean, cowpea, sunflower, buckwheat, radish, tomato and marrow bean. Other kinds may be found, as the search continues, that possess the desirable qualities in greater degree; but, somewhat in the order named, the subjects have been

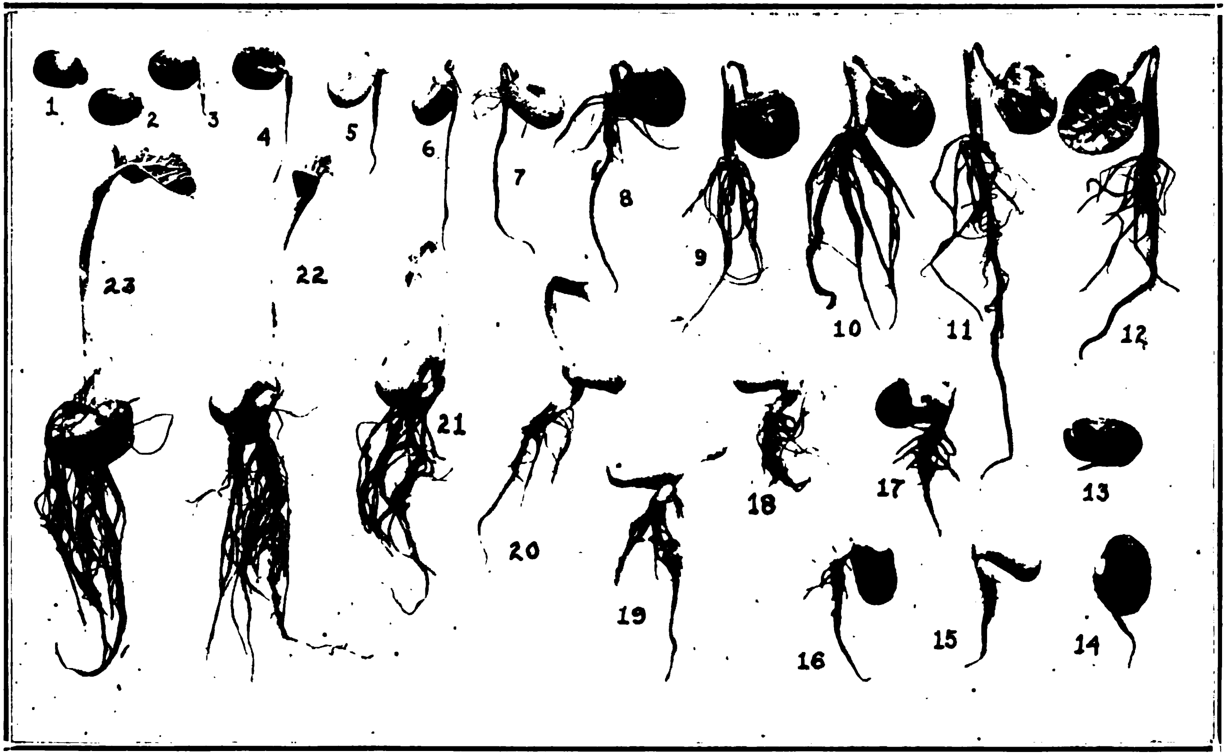

PLATE XXI.

The Hypocotyl. The upper half of the plate is occupied with a series of hypocotyls of the Castor Bean, showing various stages in its early growth. In reverse order, from right to left, is shown a similar series of the "Scarlet Runner" seedlings, with very short hypocotyls as compared with the long ones of the set above.

placed in commission. The soy bean selected is the "Ito San," and in this is found a seedling that produces with a low percentage of failures, a stout hypocotyl attaining usually its full length in ten days. The "New Era" cowpea is a more rapid-growing subject, but the cotyledons soon drop, and they do not admit of much work with them. The sunflower bids fair to be one of the best of subjects for hypocotyledonary study, its seed-stem being long and remarkably sensitive to the influence of light, gravity, etc. Buckwheat brings in another type of hypocotyl, one that is very long for its thickness with the cotyledons remaining intact nearly throughout the whole life of the plant. A strong objection to this subject is the prostration of the hypocotyl when the experiment calls for a whole or even partial exclusion of light. The radish is one of the small-seeded subjects but, like the buckwheat, its seed-stems fall to the ground too easily and the habit of seed-formation is not satisfactory. In the tomato is found a very good subject in all tests where light abounds; and here the experiments show that the dwarf and standard give distinctly different groups of results. It is in mind to develop the contrasts in lengths of hypocotyl between the standard and dwarf types of several of the commercial plants, possibly with the result that observations upon the seed-stems may be a means of determining the height of the plant that would follow.

The work of the present season, under the head of the study of the hypocotyl, has been little more than a general survey for suitable subjects in connection with a preliminary list of various environmental factors. Therefore, the following results are fragmentary and scarcely fit together in one united whole; and before entering upon these, it may be well to call the reader's attention further to the hypocotyl by means of plate illustrations. In Plate XXI. are shown seedling plants of two large-seeded types of hypocotyls—namely, the castor oil bean, shown in various stages from 1 to 12, and the "Scarlet Runner," an ornamental bean seen from 13 to 23. The castor bean has a very long hypocotyl and makes an abrupt elbow while lifting the seed-leaves out of the soil, the latter expanding into two large green leaves quite different, however, in texture and outline from the true foliage. The opposite condition of things obtains with the "Scarlet Runner" where, while the root system is quite comparable with that of the castor bean, the hypocotyl makes its entire growth during the first few days, pushing the root down before it has developed side roots and leaving the great swollen fleshy cotyledons where they were, but from between them at the same time is rising an arched first internode of the true stem. In other words, the seed-bud begins almost at once to develop and makes a great growth feeding upon the large supply of food in the gorged seed-leaves that lie, like those of the garden pea, undisturbed below ground.

The reader, by close inspection, may make out the juncture between the root system and the hypocotyl in the "Scarlet Runner" seedling but the distance is small from it to the seed-leaves; its surface is pearly white and without the rootlets characteristic of the root below.

Plate XXII. will give something of the size of the hypocotyl in the castor bean seedling at 1 to 4, these plants being much reduced in size, and the cotyledons removed in 3 and 4 for convenience in showing other parts. The hypocotyl at 1, after being marked with 2 mm. lines had its cotyledons and plumule removed several days before being photographed; and it is seen that there was considerable elongation, indicated by the greater width between the lines in the upper portion. That the growth is chiefly in the upper half of a hypocotyl is shown by the marks upon the other plants which had all their parts intact until being prepared for the photograph. When it is remembered that all black cross-lines were made 2 mm. apart, it may be concluded that the basal portion becomes woody and fixed, while the later elongation is mainly in the upper portion. At 5 and 6 are two "Hubbard" squash seedlings that illustrate the long hypocotyl and its region of greatest growth.

A Study of the Influence of Temperature Upon Length of Hypocotyl.

For the study of some of the factors of environment, a long narrow earth-holder was constructed of galvanized iron, two samples of which are shown in Plate XXIII. These cans are three feet long, six inches deep and three inches wide and have received the laboratory name of yard-can to distinguish them from pans of various sizes also employed for similar work (one of the latter of which is seen at the bottom of the plate). The same engraving shows how a test was made of the influence of temperature

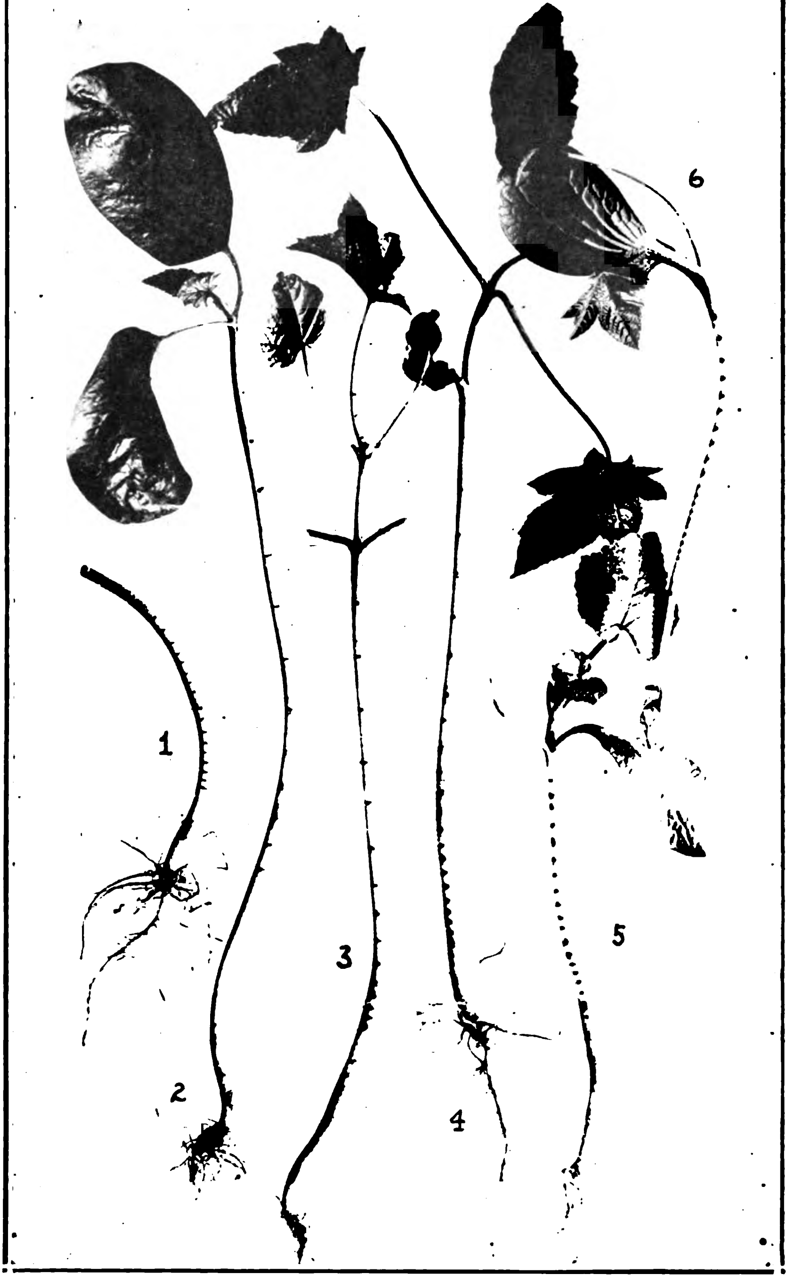

PLATE XXII.

The Hypocotyl. At 1 is shown a hypocotyl that was marked and the top removed but continued to elongate greatly in the upper portion; at 2, 3 and 4 are other seedlings of the Castor Bean, showing great growth after the hypocotyls had been marked; at 5 and 6 are squash seedlings with similarly marked hypocotyls.

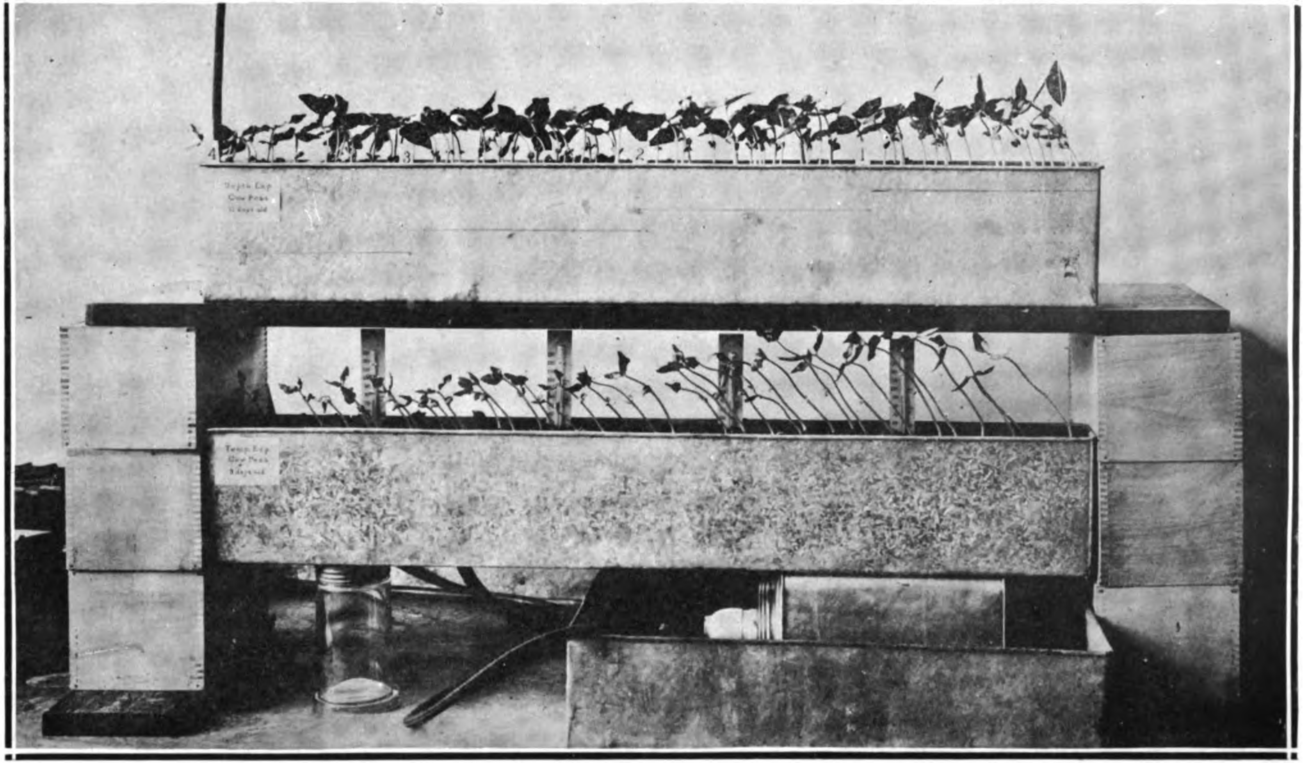

PLATE XXIII.

The Hypocotyl: Temperature and Depth of Planting in Yard-Cans. The lower yard-can with cowpea seedlings is shown in position with electric heater below; above is a depth of planting test, the yard-can having been brought from a window and held in its present place while the photograph was taken.

upon the seedling. First of all an electric heater upon a small scale was extemporized by fitting an ordinary 16-candle lamp into a tin tea-can lined upon all sides excepting the top with asbestos. The lower yard-can, with one end resting upon the heater, is shown in the position it maintained for nine days while a test was made with cowpeas. A certain number of seeds, usually 30, were planted 25 mm. deep in the middle line of the can and four thermometers placed as shown, one being directly over the warmest portion of the electric lamp. This work was done with unequal window-light and this accounts for the uniform bending of the seedlings. The upper yard-can in the picture was placed there and upheld by side boxes only during the taking of the photograph.

Considerable data have been gathered from the temperature tests but the construction of larger electric beds and a dark room have led to the beginning of a more extended research along this line and the results are left to await later presentation. However, the reader can see from the plate that the temperatures, quite uniformly maintained, as shown upon the thermometers (73°, 75°, 82° and 92° F.), had a very marked effect upon the length of the hypocotyl in the cowpea. It was much greater in the soy bean and the sunflower, seedlings that attain more slowly to the full stature of their comparatively very long hypocotyls.

Another test, with summer squash seedlings, made in the same place as the above and photographed when ten days from planting, is shown in the lower half of Plate XXIV. Here the temperatures are higher (76°, 80°, 88° and 106° F.), with the thought of having an optimum somewhere near the center of the yard-can; and it is seen that the greatest elongation of the hypocotyl was in the middle region of the can or at a temperature of 80° to 88°. The seedling at the right end of the can is enduring an upright strain of 50 grams, produced by a bag of bird-shot suspended by a thread, passing over a smooth metal rod placed above, and fastened to the plant just below the cotyledons. The results of this line of tests are not ready for this report.

A Study of the Influence of Depth of Planting Upon the Length of Hypocotyl.

As every worker with plants well knows, the depth to which the seed is buried in the soil has a great influence upon the length of that portion of the seedling, one of the prime functions of which is to raise the bud (plumule) into the air and sunlight; and therefore the deeper the planting, all other things remaining the same, the longer the hypocotyl, within the narrow limits of the maximum possible growth of such part.

In Plate XXIII., upper half, is shown a yard-can that grew a set of cowpea seedlings; the right-hand quarter with the seeds 25 mm. deep, the next 50, the third 75, and the left quarter 100 mm. deep. The can stood broad side to a south window and all parts were alike conditioned. It is seen that at the end of eleven days,—and the hypocotyls had ceased elongating at least two days earlier,—the cotyledons are all above ground but the actual length of those planted the deepest is far greater than those that required only a quarter as much elongation to reach the surface.

A similar test with summer squash seed is shown at the top of Plate XIV., where the same results in general are apparent. Here there is no confusion of true leaves for as yet at the end of ten days the cotyledons only comprised the seedlings' foliage. Not as large a percentage of the seeds grow in the deeper plantings but those in sight compare favorably with the individuals in the more shallow region.

A test of this kind shows clearly that any experiment with the influence of environment upon the length of hypocotyl requires that all seeds employed must be planted at the same depth.

A Study of the Influence of Air-Moisture Upon the Length of the Hypocotyl.

The apparatus for a preliminary study under the above head consisted of two large glass dishes, one 75 and the other 300 mm. in height into which soil 60 mm. deep was placed and sown to radishes ("Olive-Shaped Scarlet"). The tall jar was covered with a long strip of glass that extended out to one side and directly

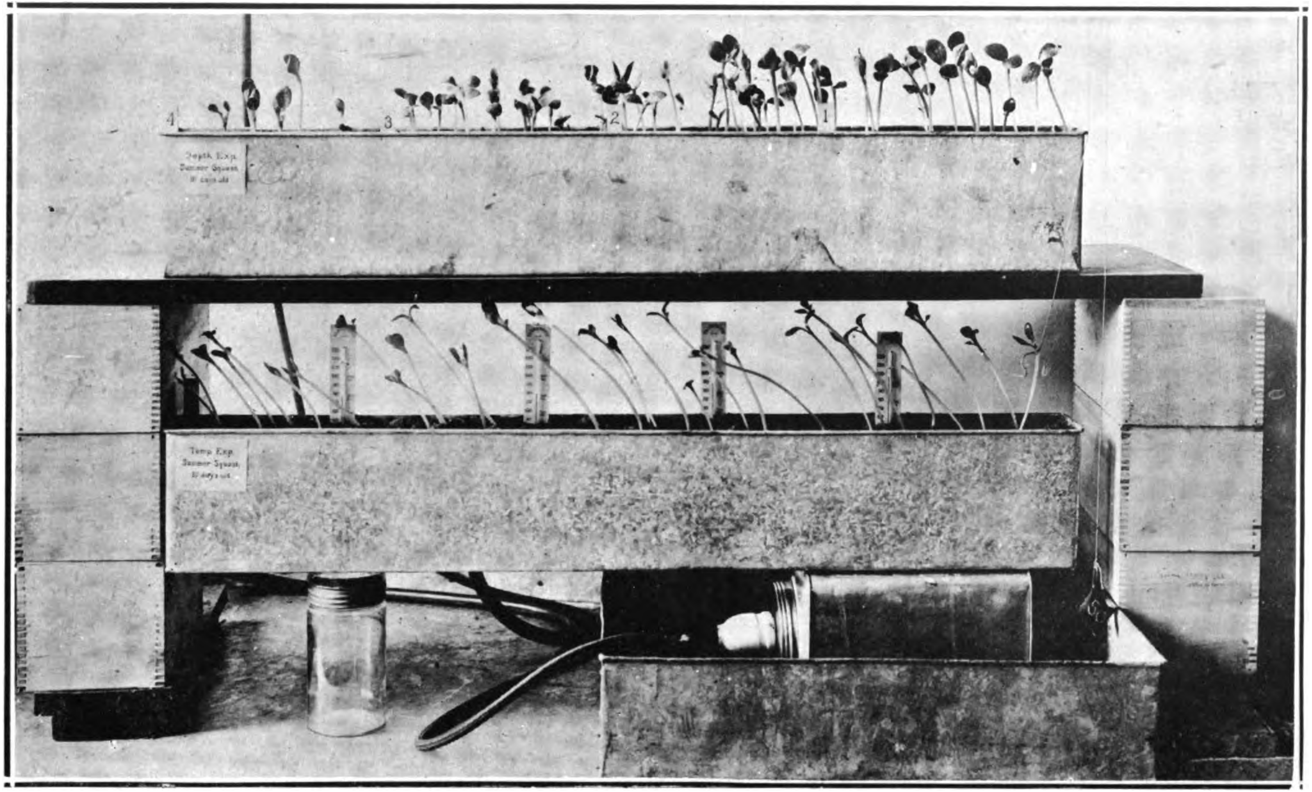

PLATE XXIV.

The Hypocotyl: Temperature and Depth of Planting Yard-Cans. The lower yard-can with squash seedlings is shown in position with electric heater below; above is a depth of planting test, the yard-can having been brought from a window and held in its present place while the photograph was taken.

over the low dish in order that both might receive all their light alike (through the same pane) from a 60 Watts lamp that was situated 125 cm. directly above and shielded by a large pasteboard cylinder and hood of black cloth. In other words, the attempt was made to have the light constant during the whole test and the moisture in the surrounding air of the two dishes the only thing unequal.

A thermometer was hung in the tall dish and another just outside of it; and they registered practically the same temperatures and averaged 7 degrees higher than the self-registration instrument outside of and two feet from the light-screen.

The following table shows the results in averages obtained from the measurement of many hundreds of radish seedlings:

	Uncovered Dish.	Covered Dish.
1	83.5 mm.	107.4 mm.
2	63.3 "	85.4 "
3	90.5 "	104.8 "
4	97.8 "	120.4 "
5	85.2 "	116.3 "
Average	80.1 "	104.1 "

A delay in receiving the hygrometers prevented their use until the last trial before going to press, during which the percentage of moisture, averaged from daily records, indicated, was: for the uncovered dish, 72.2 per cent.; and for the covered dish, 87 per cent. or a difference of 14.8 per cent. The 44 seedlings in the uncovered dish averaged 100.2 mm. and the 38 seedlings that were covered gave 125.3 mm., that is, a quarter more.

Another method of testing the same influence (and which led to the above), was by growing various kinds of seedlings in a large ice drip pan, over a portion of which a large tall bell-jar was placed. In such a chamber, the air, while not tested, indicated a complete saturation, as the water constantly covered the sides of the jar, while the control plants just outside were surrounded by the air of the laboratory which was fairly dry during the tests.

The following are some of the results that were reached in terms of hypocotyl lengths:

	Uncovered.				Covered with bell-jar.			
Buckwheat	25	seedlings;	average,	140.4 mm.	15	seedlings;	average,	157.5 mm.
	18	"	"	101.8 "	24	"	"	141.8 "
Beets	25	"	"	34.1 "	14	"	"	42.4 "
	25	"	"	28.4 "	25	"	"	37.6 "
Clover	25	"	"	23.3 "	25	"	"	27.3 "
	25	"	"	19.4 "	25	"	"	28.7 "
Cucumber	3	"	"	39.7 "	6	"	"	79.7 "
Flax	25	"	"	46.5 "	5	"	"	49.4 "
	23	"	"	31.6 "	28	"	"	55.9 "
Morning Glory	8	"	"	52.0 "	7	"	"	71.3 "
Turnip	25	"	"	61.4 "	27	"	"	67.1 "
	25	"	"	37.8 "	25	"	"	68.7 "
Radish	25	"	"	58.6 "	19	"	"	54.1 "
"Ito San" Soy Bean	30	"	"	47.1 "	26	"	"	74.3 "
	Total, 302		Average,	50.2 "	Total, 266		Average,	66.4 "

The above averages show, at a glance, that the higher content of atmospheric moisture in this set of instances seems to have increased the length of the hypocotyl by nearly a third.

A Study of the Influence of Distance Apart of Growing Seedlings Upon the Length of the Hypocotyl.

Radish seed was sown April 11th in a small bed and represented three distances from seed to seed, namely: 20, 10 and 5 mm.

A record of the average length for each group was taken with the following results:

Date of Measuring.	20 mm. apart.	10 mm. apart.	5 mm. apart.
April 18	25.0 mm.	19.3 mm.	22.2 mm.
" 19	31.7 "	27.7 "	34.2 "
" 20	34.2 "	28.8 "	35.1 "
" 21	34.8 "	34.2 "	36.1 "
" 22	36.9 "	36.7 "	39.4 "
" 24	36.9 "	36.7 "	43.2 "
" 25	38.0 "	36.7 "	43.2 "
" 27	38.0 "	39.8 "	46.9 "
" 29	39.7 "	39.8 "	44.0 "
May 1	42.4 "	39.0 "	45.3 "
" 3	39.6 "	38.8 "	48.8 "
" 5	39.9 "	40.7 "	45.5 "

This small test shows that when the plants are grown thickly, the hypocotyl is elongated, a fact that may be due to more than one condition but probably the shading produced by its neighbors is the chief one.

A Study of the Influence of Position of Seeds in the Soil Upon Hypocotyl Length.

Two hundred selected commercial "Hubbard" squash seeds were planted in an iron seed pan, 50 flatwise, 50 with root-end downward, 50 root-end upward and 50 edgewise; but all so placed in the soil as to have their center of gravity the same distance (25 mm.) below the surface of the soil.

1. The five rows planted flatwise averaged 168.8, 171.3, 184.9, 175.3, 178.4; of all, 175.7 mm.
2. The five rows planted root-end downward averaged 187.8, 194.3, 182.5, 189.6, 179; of all, 186.6 mm.
3. The five rows planted root-end upward averaged 174.9, 181.1, 179.7, 171, 165.6; of all, 174.5 mm.
4. The five rows planted edgewise averaged 169.6, 168.3, 166.2, 171.7, 170.5; of all, 169.3 mm.

The second position gave a somewhat greater length of hypocotyl than the others and the shortest average was with seeds edgewise. There were some noticeable differences in the formation of the "peg," a structure developed in seedlings of this group (Cucurbitaceae) of plants for aidng in their escape from the "shell" or seed coats.

When seeds of this flat shape are planted nearer the surface or when the soil is quite dry above them, there might be a great disadvantage in having the tender root-tip extend upward for a time, as it must do in the third position.

With round or oval seeds, like the soy bean, mustard, &c., there is probably no advantageous position in the soil.

A Study of the Influence of Size of Seed Upon the Length of the Hypocotyl.

Fifty selected large seeds of "Ito San" and having the total weight of 8.25 grams were planted in one-half of a deep ice-drip dish in a south window, June 13th, and the hypocotyls were measured ten days later. The forty-five seedlings gave a total hypocotyl measurement of 4,447 mm., or an average of 98.8 mm.

In like manner, fifty selected small well-matured seeds, weighing 6.2 grams, were planted in the half of the dish opposite the large set; and the forty-six seedlings gave 4,165 mm. of hypocotyl length, or an average of 90.6 mm.—8.2 mm. less than that of the large-seeded set.

In a similar way, fifty large seeds of "New Era," weighing in total 9 grams, were grown in competition with the same number of seeds of selected small seed, weighng 3.5 grams. The 31 seedlings from large seeds gave 1,524 mm. of hypocotyl length, or an average of 49.1 mm.; while the 34 small-seeded seedlings produced 1,574 mm. of hypocotyl length, or an average of 46.3 mm. This is only 2.8 mm. less than that of the seedlings from seeds that weighed nearly three times as much.

From these limited data, one is able only to infer that the large seeds of the same lot produce long hypocotyls, but the ratio of size of the large seeds above the small ones does not give the ratio of the length of their hypocotyls to those produced by the small ones. For example, the "Ito San" small seeds in weight were to the large ones as 3 to 4; while their hypocotyls were to those from the large seeds as 10 to 11; and in the cowpea, the seed weights were as 5 to 13 while their respective hypocotyls were as 6.6 to 7.

There are other differences often striking, as much greater thickness of seed stem, size of root-system and cotyledons; but these are in another chapter of seedling study.

A Study of Influence of Side Light Upon the Length of Hypocotyl.

A galvanized pan, 50 x 105 cm. and 15 cm. deep, was placed with one long side 40 cm. from a south window that was in width nearly the length of the pan. After being filled (12.5 cm.) with rich soil, 200 selected seeds of certain plants were planted at equal distances (5 cm.) and uniformly watered from day to day.

As the depth at which the seed is planted exerts a great influence upon the length of the hypocotyl, the soil in the seed pan was brought to a level, and by means of a thin copper plate containing equidistant (5 cm.) holes placed upon the surface of the bed, the seeds, having been dropped in the center of the circles of exposed earth, were punched into the soft soil by a cork glued to a larger one that was stopped by the copper plate; in this way each seed was located at the same depth (2.5 cm.); fine dry earth was then sprinkled upon the bed and the whole brought to a smooth surface by means of a "straight edge."

The form of registration blank used is shown herewith, the numbers of the rows being given upon the top and the left and the days of planting to that of appearing of the seedling are indicated by the single figure at the place it occupied in the rectangular field. Below these figures are the lengths in millimeters of the hypocotyls as measured at harvest and upon the right is the average for each long row and below is a similar set of averages for the short rows.

The window is a high one consisting of two 120 cm. sashes and the shades were left constantly at the top so that the difference in the amount of light seemed small especially when it is stated that there are seven other large windows in the laboratory that admit light equally with the one selected for the test. There was no window upon the side of the laboratory that faced the window directly involved in the test and therefore row 2 was 5 cm. nearer the center of the room than row 1 and, in like manner, row 10 was 45 cm. further removed from the window than row 1.

The averages of the short rows—that is, running to and from the window—should express only the variation that is due to the factors contained in the seeds unless that of location, far or near side (end) of the pan, had an influence. The long row averages shown upon the right, while expressing the variation above mentioned and inseparable from random-chosen seeds, may give the fact of the influence of light.

Sunflower.—In the case of the sunflower test, the one taken to illustrate the blank form, it is seen that there is a nearly uniform slight increase in the length of the hypocotyl from row 1 to 10, a fact that may be expressed by comparing the averages of the outer five rows, 92.9 mm., with that of the inner set, 103.7 mm. In other words, the average row in the half nearer the window corresponds in position with row 3 and that of the further half with row 8, that is, the difference in distance is five intervals between the rows or 25 cm. (10 inches). In short, under the conditions of the test in autumn, and it probably would have been different in June or January, all other factors remaining the same except the sun, the ten inches lateral distance from the window is held changed with the difference of over ten millimeters of hypocotyledonary length.

PLAN OF RECORD FOR SUNFLOWER SIDE-LIGHT TEST.

SOUTH SIDE.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Average.
1	6 115	8 101	6 88	6 67	7 73	6 55	6 88	7 91	7 68	6 83	.. ..	6 78	6 61	7 96	7 72	6 107	6 88	6 105	6 104	7 101	85.6
2	6 94	6 115	6 118	6 82	6 75	6 113	6 121	6 89	6 76	6 71	6 74	6 68	7 82	6 84	6 103	6 85	6 96	6 110	.. ..	6 121	93.3
3	6 76	6 101	6 80	6 105	7 105	10 110	7 94	7 86	7 89	7 105	6 92	.. ..	7 97	6 113	.. ..	6 107	6 66	6 102	6 115	6 89	96.2
4	6 95	6 116	6 115	6 73	7 75	6 117	6 105	7 85	6 86	6 103	.. ..	6 110	7 76	.. ..	7 85	5 99	6 91	6 87	6 118	7 65	94.2
5	6 85	7 114	6 116	6 74	6 121	6 98	.. ..	8 105	6 97	6 79	7 66	7 90	6 87	7 75	6 121	7 82	6 116	6 89	6 105	6 94	95.5
6	6 115	7 118	6 74	6 85	6 122	6 101	6 94	7 116	7 96	6 105	6 67	6 97	6 118	6 96	6 95	6 97	6 94	6 100	6 92	7 115	99.8
7	7 101	7 127	6 121	6 90	.. ..	6 84	.. ..	6 87	6 105	6 115	6 123	6 96	7 78	6 106	6 87	6 110	8 112	6 107	6 79	7 96	100.5
8	6 78	7 118	6 92	6 103	6 118	7 85	6 126	7 123	6 97	7 92	6 111	6 75	6 121	7 95	6 88	6 127	6 85	6 74	.. ..	6 99	100.1
9	6 126	6 181	6 142	6 85	6 95	6 94	7 108	.. ..	6 125	6 127	6 68	6 98	6 129	7 90	7 87	7 102	6 181	6 188	6 120	6 142	112.8
10	6 87	5 161	6 100	6 121	6 125	.. ..	6 75	6 115	6 98	6 121	7 95	6 88	6 76	·7 107	7 79	6 106	6 105	6 118	6 119	6 181	106.1
Average....	97.2	119.2	108.6	88.5	101	95.2	101.4	99.7	98.2	100.1	86.4	87.8	91.5	95.8	90.8	101.2	97.9	108	105.9	105.8	Grand Average. 98.4

From the above plan one is able to deduce the average length of hypocotyl for each set of seedlings—namely, of those that appeared at the surface in five, six, seven or eight days. As a matter of fact, a day is quite an indefinite period in this connection and all but five came through the soil in six or seven days, 140 of the 189 showing in six days.

It is to be remembered that the seeds were commercial and, while selected to a standard of size and weight, they doubtless represented many plants with varying factors for speed in growth and length of hypocotyl.

The test lasted nine days and the temperature of the room for that period averaged 20° C.; no record was kept of the soil temperature.

Cowpea.—Preceding the sunflower in time, August 9th to 15th, was a test of 200 seeds of the "New Era" cowpea. The seeds gave only a fair record for viability, as only 147 measurements were made. The row averages, beginning nearest the window, were: 61.7, 63.6, 62.4, 65.5, 62.3, 60.5, 62, 61.3, 64.3, 64.1 mm.; average, 62.7 mm. In this instance, there is no marked effect of the side light, for the five rows nearer the window averaged practically the same as that for the other five.

"Hubbard" Squash.—The same seed pan was planted to "Hubbard" squash seed (commercial) selected to a standard size, the experiment extending over ten days (September 13th to 20th), and the number of measurements out of a possible 200 was only 137. As with the other tests, there were a very few seedlings that broke earth the day before the majority and likewise there were some belated ones. The records furnish data for computing the relative vigor of those early and late seedlings as expressed in length of hypocotyl. The row averages, passing from the window row toward the center of the room, are: 109, 113.5, 116.7, 118.3, 130.1, 122.5, 130.1, 117, 128.7, 114.4 mm.; average, 119.8 mm. By grouping the nearer and further half, as before, it is seen that the two averages are 117.5 and 122.6 mm. respectively, thus showing a marked increase of the more shaded portion.

Buckwheat.—A test similar to that for the sunflower, cowpea and squash was made October 16th to 28th, a period of twelve days before the hypocotyl ceased to elongate. In this case, a record of the temperature was taken during the period and ranged from 16° to 20° C.

The row averages were: 149.7, 141.6, 141.5, 145.5, 147.8, 145.6, 152.6, 151.6, 161.4, 156.6; average, 149.1 mm. The averages for the lighter and darker halves of the bed were 145.3 mm. and 153.6 mm., respectively, thus showing an increased length in the hypocotyls grown in the darker part of the field.

The buckwheat seedlings had very slender hypocotyls and many bent down to the earth and window-ward some days before the test terminated. All the four kinds of seedlings thus far considered leaned more or less toward the window, the least being the cowpea, followed by the sunflower, squash and buckwheat, as just mentioned.

A Study of the Influence of Interrupted Gravitation Upon the Hypocotyl.

The yard-cans previously mentioned are of suitable size and shape for a test of gravity influence upon the length of hypocotyl. Thirty selected seeds of "Ito San" were planted an inch deep in the middle line lengthwise of the can and placed in the dark room with a control can. As soon as the cotyledons showed above ground, two-inch strips were tied lengthwise upon the top of the earth to prevent the soil from falling out, and the can was then turned upon one side; twenty-four hours later, with the plants bent upward, the can was turned upon the opposite side so that the hypocotyls needed to swing through 180 degrees to right themselves. The seedlings were reversed twice a day when needed, and as the period of elongation was nearing its end (determined by test rods in the control can), the can was left upright for two days and then the seedlings were measured.

The 21 seedlings subjected to change of position averaged 110.1 mm., while the 16 seedlings in normal position averaged 215.5 mm. It is seen that the seedlings subjected to the disturbance above described were only 51.1 per cent. the length of those grown undisturbed.

An identical test was carried out at the same time with sunflower seedlings, with the result that the turned set of 28 seedlings gave an average of 203 mm., while the check of 29 plants averaged 218.4 mm. In this instance the difference was only 7.5 per cent.

The soil-temperature varied from 14° to 17° C.

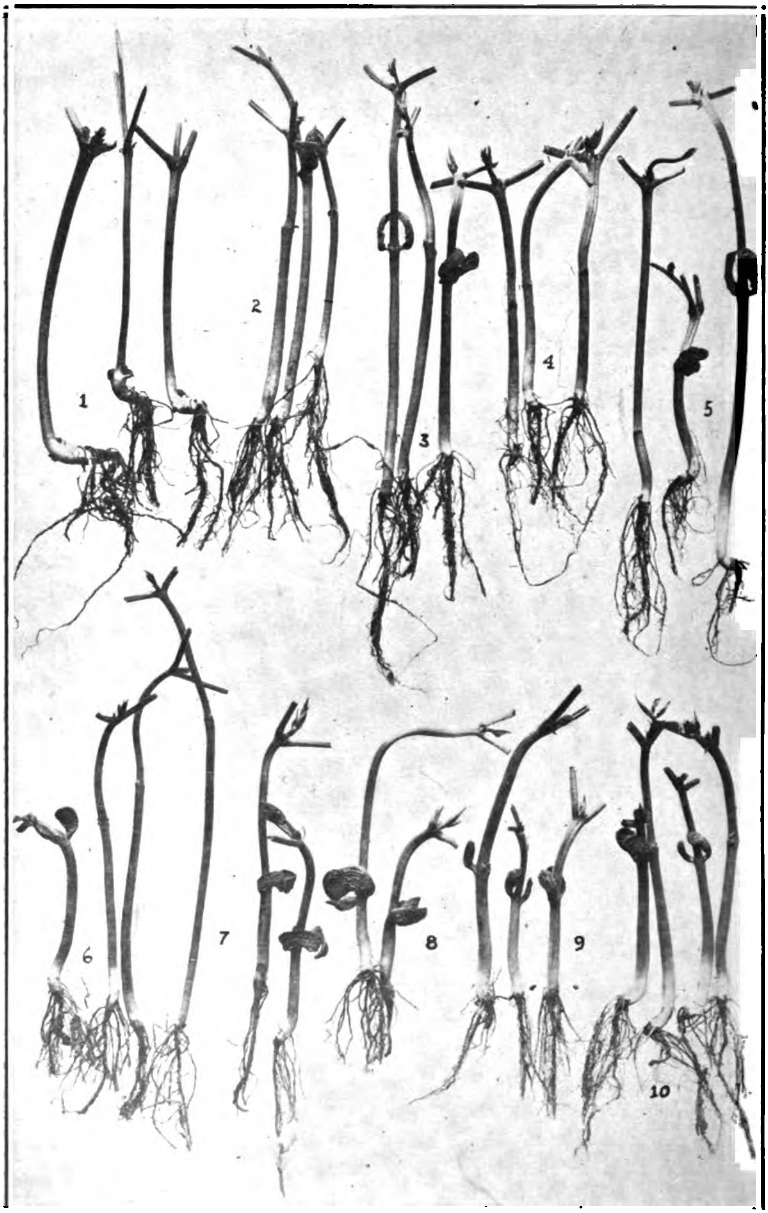

PLATE XXV.

Hypocotyl in Hybrid Beans. At 1 are shown the very short hypocotyls of the "Scarlet Runner" and at 10 the comparatively very long ones of the "Tennessee" snap bean; the eight groups between them are of seedlings of groups of hybrids in which the hypocotyl is very variable and often exceeding in length that of its parent, the "Tennessee."

A Study of the Length of Hypocotyl in Hybrid Beans.

The hybrid seedlings of the "Scarlet Runner" bred upon the common snap beans, as might be expected, show great variations in the length of the hypocotyl. The "Runner" has a hypocotyl so short that the seed-leaves remain stationary below ground in germination, as illustrated by their scars at 1 in Plate XXV., where three samples are given. In like manner, at 10 are shown three hypocotyls of the "Tennessee" bush bean. At 2, 3 and 4 are illustrated three samples each of the hybrid seedlings of the two species above named and representing the second, third and fourth generations respectively. It is noted that the length of hypocotyl in some of the specimens far exceeds the combined length of both parents. At 7 and 8, upon the other hand, the seed stem is much shorter than the parental average. Each group of three is selected for range of variation from seedlings of the same parent and this shows that the average length varies greatly among the groups—that is, the hypocotyls from one line of descent may be very different from those of another and probably by selection might be fixed to conform to a well-defined measurement.

The first internode shows as wide a range of variation and this length does not seem to be correlated with that of the hypocotyl; but this, while worthy of amplication, is not to the present purpose.

A Study of Mutilation of Seedlings.

The seedlings so soon as they came through the soil had their cotyledons cut, as follows: (1) one-half of one cotyledon removed (as shown at 2 for soy beans and at 8 for sunflowers in Plate XXVI.); (2) one-half of both cotyledons removed (at 3 and 10); (3) one cotyledon entirely removed (at 4 and 9); and (4) with both cotyledons removed (shown only with soy beans at 5 in the plate). This engraving shows (at 6 and 11) a group of each of the two subjects with the hypocotyls tied with strings but this treatment is not now considered.

The following are some of the results obtained:

(1) Soy Bean, "Ito San," grown in greenhouse, measured May 24th, 1911.		
Grown normally, seven days old, 79 seedlings, average length of hypocotyl	57.8	mm.
With one-half of one cotyledon removed after five days, 29 seedlings, seven days old, average length of hypocotyl	53.2	"
With one-half of each cotyledon removed after five days, 16 seedlings, seven days old, average length of hypocotyl	48.0	"
With one cotyledon removed after five days, 26 seedlings, seven days old, average length of hypocotyl	51.8	"
With both cotyledons removed after five days, 16 seedlings, seven days old, average length of hypocotyl	45.5	"
(2) Soy Bean, "Ito San," grown in greenhouse, measured June 1st, 1911.		
Grown normally, 78 seedlings, seven days old, average length of hypocotyl	56.5	mm.
With one-half of one cotyledon removed, 36 seedlings, seven days old, average length of hypocotyl	54.8	"
With one-half of each cotyledon removed, 45 seedlings, seven days old, average length of hypocotyl	54.0	"
With one cotyledon removed, 40 seedlings, seven days old, average length of hypocotyl	53.0	"
With both cotyledons removed, 35 seedlings, seven days old, average length of hypocotyl	44.0	"
(3) Sunflowers, grown in greenhouse, in May, 1911.		
Grown normally, four lots of seedlings, total of 105 plants, average length of hypocotyl	89.5	"
With one-half of one cotyledon removed, four lots of seedlings, total of 49 plants, average length of hypocotyl	90.1	"
With one-half of each cotyledon removed, four lots of seedlings, total of 62 plants, average length of hypocotyl	84.4	"
With one cotyledon removed, four lots of seedlings, total of 60 plants, average length of hypocotyl	83.9	"
With both cotyledons removed, three lots of seedlings, total of 43 plants, average length of hypocotyl	57.3	"
Average age of four lots, 11.3 days.		

It is noted that the removal of a portion of the seed-leaf, or the whole of one or both, has a marked effect upon the length of the hypocotyl.

In the case of the sunflower, samples of which are shown in the lower half of Plate XXVI., the hypocotyls exceed those of the soy bean, and their ratio of diminution due to mutilation is different, but in general the results are similar.

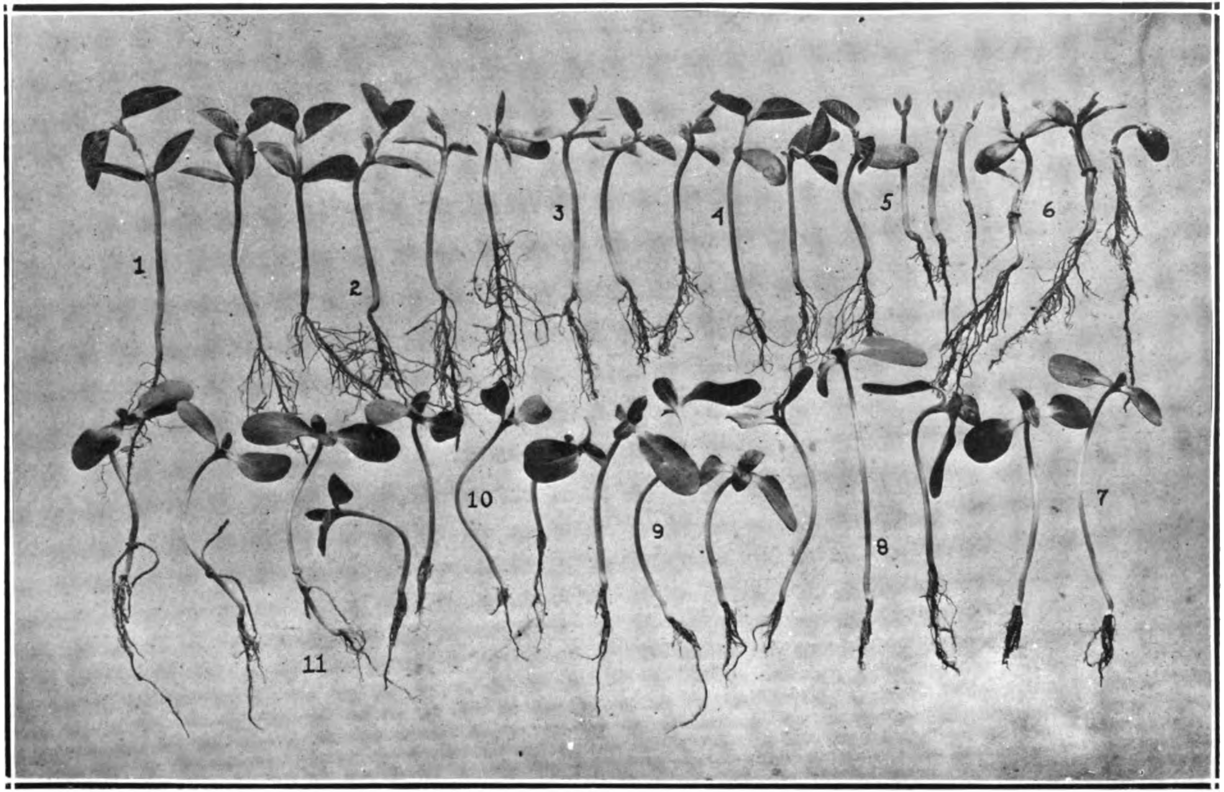

PLATE XXVI.

Hypocotyls of Mutilated Seedlings. The upper row shows soy bean seedlings, normal at 1; a half cotyledon removed at 2; both half off at 3; one off at 4; and both off at 5. A similar set of sunflower seedlings, with the omission of both cotyledons removed, is shown in the lower half of the plate.

Hypocotyls Grown In Electric Seed Beds.

From two electric seed beds installed during the autumn now closing, two crops of seedlings have thus far been harvested. The bed consists of a deep metal pan in the bottom of which twelve electric lamps, three upon each side, are placed and the bottom and sides of the pan covered thickly with asbestos. Into this pan another similar one, three feet square and eight inches deep, is set and all held in a stout wooden frame upon one side of which the twelve lamp switches are arranged. With the pan filled to any desired depth with soil and the seeds planted, the lights—entirely hid from view—can be turned on, one, two or three as the desired temperature demands.

One of these electric beds is set in a room provided with light-tight shades and can be made dark, or illuminated with artificial light as the test requires. By means of thermometers placed at different depths in the soil, a full record of the soil-temperature can be made. The other bed is placed in the corner of the laboratory where two unusually large windows, south and west exposure, provide light that compares favorably with many greenhouses.

Thus far the two beds have been treated alike, excepting the light as above stated. The first trial was with eight kinds of seeds, to determine which seedlings would be best adapted to the work, particularly in the dark bed.

The method of determining the influence of the various factors of environment is the measure of the length of the hypocotyl and the following table shows the results with several kinds of seedlings. The temperature in this case was not taken with soil thermometers, but the test being made in mid-autumn was close to that recorded upon the self-registering instrument installed nearby in the laboratory.

The following are the preliminary results given in terms of the averages of the 32 samples employed in each case:

	Light Room.	Dark Room.
"Marrow" Bean	65.5 mm.	123.9 mm.
"New Era" Cowpea	56.9 "	94.8 "
"Ito San" Soy Bean	80.3 "	217.0 "
"Hubbard" Squash	85.0 "	212.5 "
Buckwheat	126.5 "	295.0 "
Tomato, Standard	37.1 "	107.2 "
Tomato, Dwarf	23.9 "	47.3 "
Radish	88.2 "	151.7 "
Average of above	70.4 "	156.2 "

It is seen that there is much variation in relative length in light and dark of the seed-stems and, while buckwheat and "Hubbard" squash and radish, for example, have great power of elongation in the dark, at the same time the hypocotyls are weak and fall to the ground before their elongation ceases and are therefore not suited for the work in question. The cowpea and soy bean proved the most stable, and because of its greater period of growth, as well as extended length, the latter was selected for the regular test.

The bed, consisting of sixteen square feet, admitted of twenty rows each way, that is, 400 seedlings, as the following plan shows:

PLAN OF "ITO SAN" SOY BEAN TEST AS RECORDED IN MILLIMETERS OF HYPOCOTYL LENGTH FOR THE FIRST CROP IN THE LIGHT.

WEST SIDE.

																					Average.
	103	88	..	57	76	96	90	..	..	88	87	70	75	78	95	82	..	98	88	87	84.9
	98	97	90	96	72	..	64	..	88	95	94	84	..	..	84	85	86	88	78	77	86.0
	100	92	75	80	75	83	64	..	87	80	85	85	97	85	85	63	80	82	91	82	82.7
	111	100	..	88	87	85	65	..	90	90	..	80	87	90	80	..	84	88	85	80	86.9
	110	105	85	87	82	83	88	..	72	90	50	..	88	85	..	..	67	72	87	94	84.1
	110	108	90	75	75	86	83	88	73	90	90	..	..	85	87	92	81	..	83	85	87.1
	93	114	88	60	90	82	77	87	84	92	87	84	88	..	94	83	90	90	90	88	87.4
	...	108	..	70	90	76	64	83	90	91	88	90	84	92	92	87	90	82	87	92	86.4
	93	78	94	83	..	86	60	..	77	60	81	..	88	84	76	77	88	91	65	77	79.9
	116	..	90	92	92	90	93	82	83	84	93	90	..	87	60	83	82	..	82	88	87.5
	123	80	90	70	97	82	50	87	88	80	87	65	..	84	..	80	78	63	70	82	80.9
	120	86	85	90	..	92	88	92	82	84	93	90	70	77	..	90	94	50	84	77	85.8
	78	75	88	95	64	78	82	87	85	95	80	86	84	..	..	88	93	90	93	98	85.5
	92	98	93	..	100	..	50	97	87	95	93	65	..	95	78	87	57	91	92	..	85.6
	60	97	77	85	88	93	57	80	83	..	84	97	81	92	92	..	80	..	70	88	82.6
	100	92	60	90	72	94	..	82	84	96	95	93	90	86	81	93	87	..	80	82	86.5
	100	98	98	92	94	...	86	90	94	97	66	93	93	87	84	65	84	92	92	63	87.8
	...	..	93	91	50	...	...	..	70	..	..	87	..	..	95	77	83	88	86	80	81.8
	105	78	92	62	83	102	105	..	82	..	88	90	100	84	97	..	88	95	..	87	89.9
	110	98	95	..	62	98	83	82	95	..	90	95	..	101	98	97	88	82	75	86	90.8
Average....	101.2	94	87.2	81.3	80.5	87.9	74.9	86.4	83.9	87.8	85.1	84.9	86.5	87	86.1	83.1	83.2	83.9	88.1	88.9	Grand Average. 85.5

It is observed that the averages for the south side rows are higher than elsewhere, which is accounted for largely by the shading that the side of the pan produced. With the pan filled to the top, this factor in variability can be removed. There is another factor that may enter—namely, a somewhat different soil moisture content along the edges of the pan which, while slight, may be overcome by excluding the outer row in the measurements or its equivalent, making the border around the field wider. A check upon the value of this outer row of seedlings is found in the set grown in the dark, the plan for which is presented below.

PLAN OF "ITO SAN" SOY BEAN TEST AS RECORDED IN MILLIMETERS OF HYPOCOTYL LENGTH FOR THE FIRST CROP IN THE DARK.

WEST SIDE.

																					Average.
	...	177	...	...	...	166	163	168	...	85	180	117	177	121	175	172	178	125	180	105	152.6
	162	185	148	177	160	177	180	188	130	167	110	170	...	...	174	165	90	...	177	172	157.5
	183	180	165	105	183	78	100	72	152	146	175	165	...	187	172	...	...	170	157	173	147.8
	175	172	187	...	173	180	...	140	80	147	...	...	172	...	110	172	175	...	187	184	153.9
	...	162	177	173	...	...	176	...	...	165	108	178	177	97	162	152	168	187	170	174	161.4
	147	170	...	146	178	183	145	140	...	160	172	170	...	...	170	170	...	172	...	...	163.1
	85	...	174	...	172	...	...	...	160	180	180	...	173	154	...	...	168	...	172	...	161.8
	...	95	...	170	160	170	160	172	170	110	162	167	160	178	173	162	160	...	...	156	157.8
	150	...	112	175	...	80	...	175	...	...	177	80	147	115	140	162	182	106	146	175	141.5
	...	168	115	...	105	...	157	172	178	163	162	173	...	160	176	165	...	...	...	162	157.8
	...	133	...	155	...	...	120	170	160	168	148	149	92	140	170	148	...	176	140	178	148.8
	165	167	...	185	...	182	...	167	...	165	...	167	...	...	...	113	180	180	172	160	162.8
	140	175	170	152	...	...	147	...	168	...	143	...	...	150	177	182	185	180	158	184	161.1
	160	...	162	165	170	178	152	171	168	162	170	155	172	165	...	170	...	112	152	176	161.8
	...	163	170	...	163	83	152	140	163	155	173	100	175	172	162	188	...	110	185	...	147.1
	165	167	150	...	162	155	145	...	...	75	153	...	142	153	183	...	182	165	157	165	154.6
	170	146	165	170	157	188	152	167	145	120	164	167	...	177	170	160	157	167	170	177	162.0
	165	140	157	152	...	170	180	160	145	137	...	163	...	...	1[illegible]5	140	...	...	156	85	151.8
	180	120	166	163	84	187	173	150	178	155	115	178	162	170	...	175	...	155	...	110	150.9
	180	165	127	180	...	177	126	188	173	180	135	85	180	...	164	...	177	...	...	177	153.9
Average....	159.1	157.6	156	154.9	155.6	149.6	151.8	155.8	153.6	143.6	154.1	149	160.8	149.2	165.8	156	166.4	154.2	158.6	159.8	Grand Average. 155.8

In the above tests only four lamps were turned on, one in the middle of each side; and the nine-day records of the two soil thermometers (placed, one near a corner and the other at the center of the bed, and five centimeters below the surface) averaged as follows:

										Average.
Light	25° C.	25	25	24	28	29	28	26	26	26.2° C.
Dark	25	27	30	29	28	29	28	26	28	27.7

The heat for the dark room was a degree and a half higher than in the light, a modifying factor that needs to be considered.

A duplicate test of the above was made with "New Era" cowpea, planted October 13th at 4 P. M., and harvested October 20th, 4 P. M. Out of the 400 seeds planted for growth in the light, only 222 produced measurable seedlings. The harvest was row by row, with the following averages in millimeters: 93, 83.1, 85.2, 87.4, 88.7, 86.4, 79.6, 84.8, 86.5, 87.8, 84.1, 85.3, 83.4, 86, 82.2, 84.8, 85.9, 83.4, 86.5, 84.8; the whole sum of lengths being 18,970, thus giving the average length of hypocotyl as 85.5 mm. The temperature averages from twice-daily records was just 31° C.

The corresponding planting for the dark room, which began and ended upon the same dates as the test in the light, gave, row by row, the following measurements in millimeters: 146.8, 128.2, 123.7, 126.4, 142, 122.5, 125.1, 129.1, 121.8, 127.5, 121.3, 123.2, 104.3, 113.3, 113.6, 131.5, 127.4, 129.3, 126.2, 133.7; with a total length of 27,942 mm. from 223 instances and an average length of hypocotyl of 125.3 mm. The temperature was the same as in the control test, namely, 31° C.

A STUDY OF MAPLE SEEDLINGS.

An opportunity offered for some measurements of the hypocotyls of the Norway Maple (*Acer platanoides l.*), as shown in the following table:

1. UPON HIGH GROUND (HIGH SCHOOL GROUNDS).

May	1st.	Number	of	seedlings,	142;	average	length	of	hypocotyl,	35.2	mm.
“	2d.	“	“	“	253;	“	“	“	“	36.3	“
“	3d.	“	“	“	193;	“	“	“	“	35.6	“
“	4th.	“	“	“	74;	“	“	“	“	36.0	“
“	13th.	“	“	“	12;	“	“	“	“	29.8	“

The measurements made upon the 13th showed that there had been no increase and it is quite evident that all the previous records were of seedlings with their hypocotyls of full length, and these 662 seedlings gave an average of 35.8 mm.

Another set of measurements was made of seedlings gathered from a situation somewhat different from the first, namely, level land and probably much more moist.

2. COMPARATIVELY LOW GROUND (PORTION OF COLLEGE CAMPUS).

May	2d.	Number	of	seedlings,	45;	average	length	of	hypocotyl,	43.8	mm.
“	4th.	“	“	“	103;	“	“	“	“	89.8	“
“	5th.	“	“	“	83;	“	“	“	“	41.6	“
“	6th.	“	“	“	107;	“	“	“	“	41.7	“

The average for the whole 338 seedlings is 41.1 mm., or 5.3 mm. longer than those upon the comparatively dry slope of the High School grounds.

A further set of measurements was made of maple seedlings that were growing along a fence upon the College grounds, and where shade and moisture were greater than in the last set.

3. MOIST, SOMEWHAT SHADED LOCATION.

May	2d.	Number	of	seedlings,	11;	average	length	of	hypocotyl,	89.7	mm.
“	4th.	“	“	“	48;	“	“	“	“	67.4	“
“	6th.	“	“	“	41;	“	“	“	“	75.0	“

The average for the 100 seedlings, favored for their early growth, at least, was 72.9 mm., or more than twice that of those collected upon the dry sun-exposed ground.

It is seen that the length of the Norway maple hypocotyl is subject to great variations as the young plants are found growing where light and moisture, in particular, of the many modifying factors are unequally supplied.

WEATHER NOTES FOR THE GROWING SEASON.

Upon page 383 is given a table of the rainfall during the growing season, April 1st to October 1st, for the whole State for the past twenty-three years. It is seen that the last season ranks eighth for amount of rainfall, and this is somewhat above the average for precipitation. But this has fallen quite irregularly, giving a very dry May and low averages for July and September; while the alternate months, April, June and August, were wet, particularly August, when nearly nine (8.91) inches fell, the general average for that month being 5.12 inches. In short, the early part of the season was too dry and the late portion too wet for the best growth of truck crops.

The temperature record for the same period is given upon page 384 and it ranks among the warm seasons, being exceeded by only six out of the twenty-three recorded herewith. When compared with the average, April is seen to have been cool; May and July very warm; and June, August and September very close to the normal.

A table for sunshine is given upon page 385 and it shows that the past season was a darkish one, there having been only five that had less clear-partly-cloudy weather.

In brief, the growing season for 1911 was a moist (not wet), warm (approaching hot) and moderately dark one, with the fluctuations in the above meteorological factors somewhat rapid and occasionally violent.

The data for the above notes were kindly furnished by Professor L. A. Judkins, Director of the New Jersey Section of the United States Weather Bureau.

RAINFALL OF THE GROWING SEASON FOR PAST TWENTY-THREE YEARS.

	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	Average.
April	5.32	2.65	2.19	2.49	5.21	3.09	4.88	1.35	3.79	3.74	1.73	2.29	6.31	3.62	3.97	3.43	2.88	3.64	3.78	2.72	5.97	5.34	4.11	3.66
May	4.09	4.24	2.97	5.04	4.07	7.72	2.85	3.21	5.68	7.00	1.92	4.71	5.60	2.04	0.59	2.60	1.71	4.21	5.05	7.10	2.30	2.54	1.37	3.86
June	3.73	3.59	2.92	3.85	2.95	2.28	3.24	5.46	3.38	2.10	2.50	3.08	1.57	6.57	7.68	3.13	3.43	4.48	4.41	2.32	3.26	5.17	5.36	3.76
July	10.19	5.62	5.30	4.03	2.72	1.66	4.26	5.50	11.42	4.96	5.75	4.74	5.87	4.78	5.51	4.87	4.06	5.58	2.62	4.70	2.12	1.36	8.64	4.83
August	5.18	4.90	5.32	3.63	6.52	2.58	1.83	4.39	5.36	4.36	2.68	9.43	3.91	6.95	6.95	6.62	5.72	5.95	3.45	5.05	4.57	3.78	3.91	5.12
September...	8.36	4.75	2.46	1.81	3.30	7.46	1.07	4.37	1.65	2.00	5.88	2.86	3.38	5.65	3.34	4.79	5.23	2.19	8.08	2.09	3.30	2.39	2.88	3.88
Totals.....	36.87	25.75	21.16	20.85	24.77	24.79	18.13	24.28	31.28	24.16	20.46	27.11	26.64	29.61	28.04	25.44	23.03	26.05	27.39	23.98	21.57	20.58	26.27	25.11
Average...	6.14	4.29	3.53	3.47	4.13	4.13	3.02	4.05	5.21	4.03	3.41	4.52	4.44	4.93	4.67	4.24	3.84	4.34	4.56	4.00	3.59	3.43	4.38	4.18+
Rank in wetness....	1	10	19	20	13	12	23	14	2	15	22	6	7	3	4	11	17	9	5	16	18	21	8	
Rank in dryness....	23	14	5	4	11	12	1	10	22	9	2	18	17	21	20	13	7	15	19	8	6	3	16	

TEMPERATURE OF THE GROWING SEASON FOR PAST TWENTY-THREE YEARS.

	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	Average
April	51.2	50.4	52.0	49.3	49.2	50.3	49.1	52.4	50.4	47.8	49.9	50.8	48.3	50.2	50.9	46.7	49.9	51.2	45.2	51.2	50.2	53.5	47.4	50.0
May	62.3	60.7	59.5	60.1	59.4	61.4	60.9	65.3	60.6	58.5	61.1	60.9	58.6	60.3	62.7	62.8	61.4	61.0	55.4	61.6	60.0	60.0	64.5	60.8
June	69.9	70.7	69.7	72.4	69.7	70.6	71.7	68.1	66.1	70.1	72.3	70.4	70.0	67.5	64.0	68.6	68.3	70.4	64.7	69.9	70.0	66.9	68.9	69.1
July	73.4	72.5	70.1	74.3	73.9	75.7	70.9	75.0	74.1	75.3	74.7	75.9	77.3	73.0	73.3	72.3	74.4	72.8	73.6	75.6	71.6	75.3	76.0	73.9
August	69.6	71.5	72.3	73.4	72.8	70.9	74.2	73.6	71.0	74.8	72.3	76.3	73.8	70.1	68.4	70.8	71.1	74.6	70.5	70.6	70.2	70.4	72.1	72.0
September...	64.8	64.4	68.7	64.2	62.7	68.3	69.7	65.1	65.5	68.6	64.4	69.9	66.8	64.6	65.0	64.8	65.4	68.9	67.1	65.7	64.5	67.3	66.4	66.1
Average...	65.2	65.0	65.4	65.6	64.6	66.2	66.1	66.6	64.6	65.9	65.8	67.4	65.8	64.3	64.0	64.3	65.1	66.5	62.7	65.8	64.4	65.6	65.9	65.3
Rank in warmth....	14	16	12	11	17	4	5	2	18	6	8	1	9	20	22	21	15	3	23	10	19	13	7	
Rank in coldness...	10	8	12	13	7	20	19	22	6	18	16	23	15	4	2	3	9	21	1	14	5	11	17	

SUNSHINE OF THE GROWING SEASON FOR THE PAST TWENTY-THREE YEARS IN PERCENTAGE OF CLEAR-PARTLY-CLOUDY DAYS.

	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	Averag
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
April	53	76	80	53	60	70	60	76	83	62	87	77	50	70	66	70	77	83	67	77	70	67	66	69.7
May	65	66	64	71	69	65	78	71	78	52	77	75	58	84	84	84	74	77	68	61	68	65	81	71.5
June	66	80	76	76	70	83	73	73	80	87	84	80	87	83	53	77	77	73	73	93	63	63	63	75.1
July	58	76	69	84	87	84	78	74	68	74	77	87	71	71	84	74	81	81	64	81	75	77	77	76.0
August	74	77	61	78	81	80	90	87	84	77	71	84	71	90	65	81	74	68	84	65	65	61	68	76.8
September....	53	66	83	87	73	66	90	70	87	88	80	80	80	60	83	80	76	80	60	63	60	73	73	74.2
Average....	61.5	73.5	72.2	74.8	73.3	74.7	78.2	75.2	80.0	72.5	79.3	80.5	69.5	76.3	72.5	77.7	76.5	77.0	69.3	73.3	66.8	66.7	71.3	73.8
Rank in brightness..	23	12	17	10	13	11	4	9	2	15	3	1	19	8	16	5	7	6	20	14	21	22	18	
Rank in darkness....	1	12	7	14	11	13	20	15	22	9	21	23	5	16	8	19	17	18	4	10	3	2	6	

B. H. ALFRED GROTH, Ph.D.

Heredity and Correlation of Structures in Tomatoes.

The work was continued as outlined in last year's report. The results of the study of the F_1 heredity of leaf characters were published in bulletins 238 and 239. Another bulletin, on the F_1 heredity of size, shape, and number in tomato fruits, is in course of preparation.

Two thousand five hundred plants were grown this year, representing descendants from 71 of the 135 crosses. All cotyledons and first leaves of these plants were preserved for study in continuation of the work covered by bulletins 238 and 239. Fruits were taken from each individual plant, and records made of their size, shape and number of seed cavities. Specimens of the large leaves of all plants were pressed, and leaves and parts of stems of all plants were preserved in formalin for microscopic study.

Though there has been no time to assimilate any of the results obtained from this second generation of crosses, a few striking facts appear on the surface, as for example:

1. The great fluctuation in shape of fruits on the same plant, noted in the first generation, in crosses between "Plum" and flat tomatoes, disappeared in the second generation.
2. Long tomatoes (with polar diameter exceeding equatorial diameter) may appear in the second generation of crosses between round and flat tomatoes. (Plate XXVII., 3.)
3. "Pear" tomatoes may appear in the second generation of crosses between "Plum" tomatoes and round or flat fruited types. (Plate XXVII., 5.—Plate XXVIII., 3.)
4. The heredity of the factors of size and number in tomato fruits, though resembling Mendelian inheritance, is either of a somewhat different nature, or it is obscured by other factors. (Plates XXVII. and XXVIII.)
5. The slaty color of the "Peach" tomato foliage and the smoothness of stem of the "Currant," both dominant in the first generation, are still predominating, to a varying degree, in all individuals of all of their crosses, in the second generation.

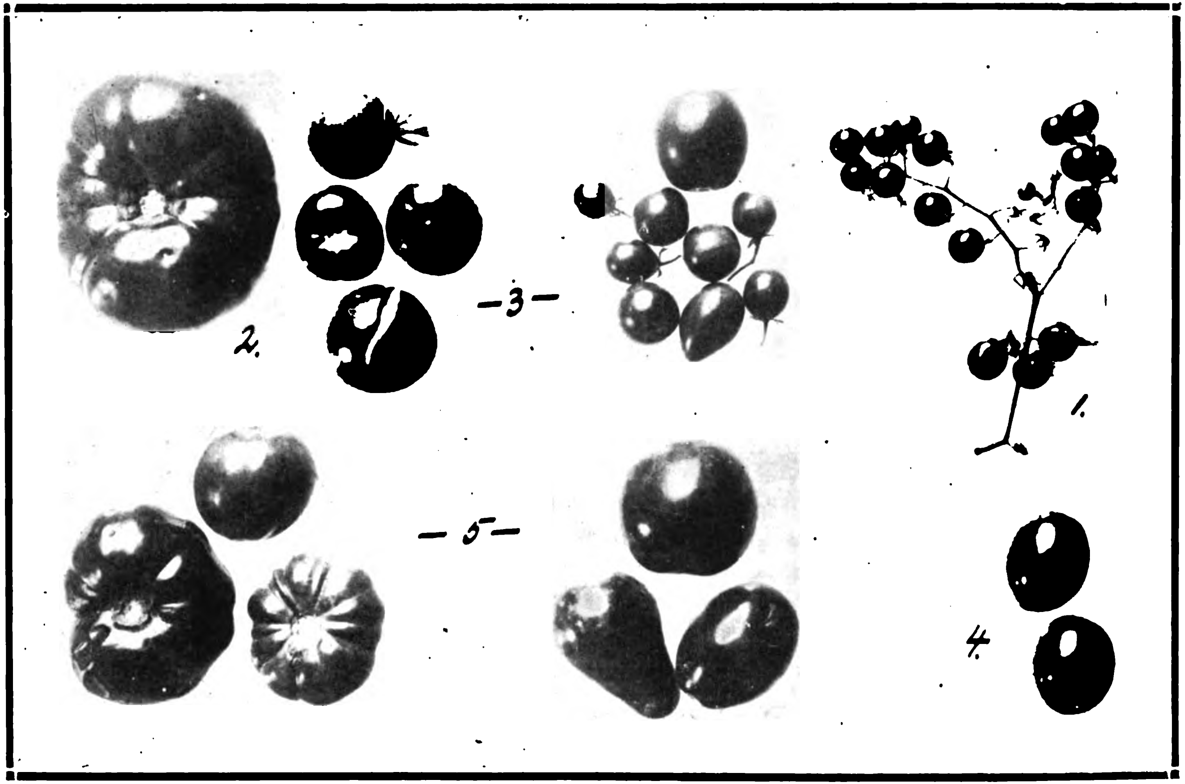

PLATE XXVII.

Tomato Crosses. 1, "Currant"; 2, "Ponderosa"; 3, "Currant-Ponderosa" F_2; 4, "Plum"; 5, "Plum-Ponderosa" F_2.

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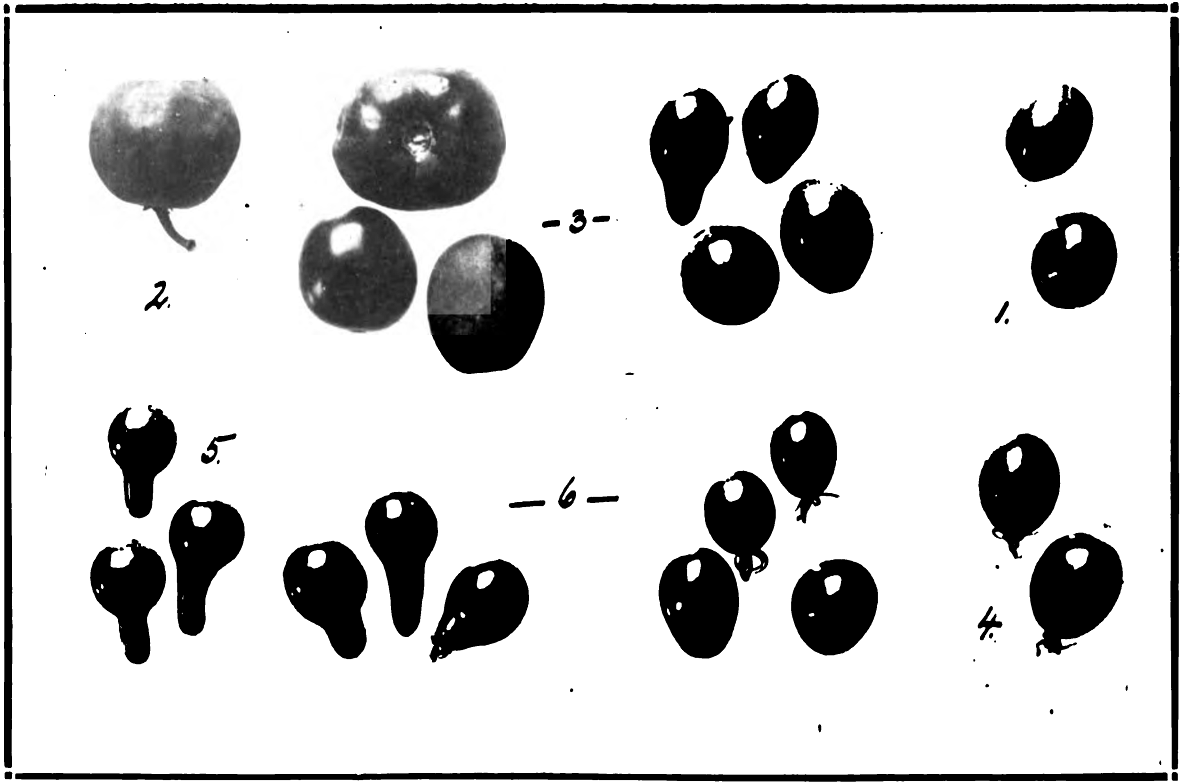


PLATE XXVIII.

Tomato Crosses. 1, "Plum"; 2, "Peach"; 3, "Plum-Peach" F_2; 4, "Plum"; 5, "Pear"; 6, "Plum-Pear" F_2.

Cell-Number in the Fruit of the Prairie Berry.

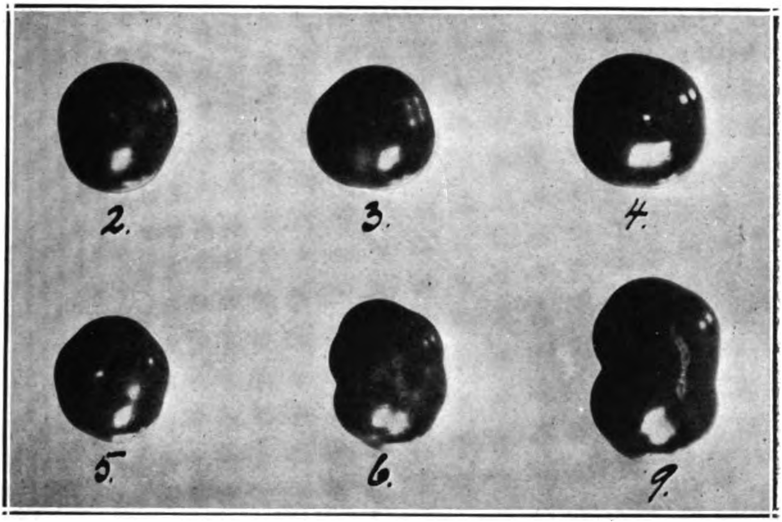
Work was continued on the selection of the prairie berry for many-celled, fasciated fruits. Seeds from 2-celled, 3-celled, 4-celled, 5-celled, and fasciated fruits of several plants with different records were planted in the field. All of their fruits were harvested and examined as to the number of seed cavities. (In all fruits ranging in number of seed cavities from two to five, the number can be told from the outside, by the shape of the fruit. See Plate XXIX.) The total count included upward of 200,000 fruits. At this time the records have not been thoroughly assimilated; but it is already clear that in the best strains there is a marked advance over last year in the percentage of fruits with more than 2-seed cavities, in the percentage of fasciated fruits, and in the absolute number of seed cavities in the large fasciated fruits. The highest number of seed cavities found in any one fruit has risen since 1908 at this rate: 1908—6 cells; 1909—8 cells; 1910—9 cells; 1911—13 cells.

With a view towards determining the physiological effects of certain salts and color solutions applied in large quantities, upon different plants, a series of experiments was begun with sand and soil cultures.

The cultures were made in 2-gallon glazed crocks without outlet. The sand cultures received such an application of C. P. fertilizer as had previously produced as large and healthy plants in pure sea sand, as the control pots of garden soil. All experiments were made in duplicate. Besides the fertilizer, salts of K, Na, Ca, or N were added in excess, in such ratios that the effects of a certain percentage of K_2O could be compared with the effect of an equal percentage of Na_2O, SO_3 with H_2PO_3, NO_3 with Cl, etc.

Eosin, fuchsin and nigrosin were fed to the roots of plants growing in garden soil, and the different effects on the different plants noted.

In both sets of experiments the plants differed considerably in their sensitiveness to the various poisons. Certain discolorations seemed to be regular effects of certain Ca salts on various plants. Eosin was deadly to some plants within twelve hours, while in other plants it developed peculiar color markings (see Plate XXIX.); some plants seemed to be entirely indifferent to it, while still others seemed to be benefited by a small amount of eosin. These experiments are being continued.



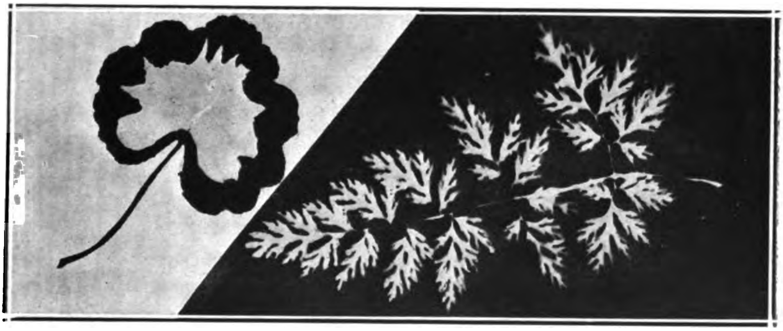


PLATE XXIX.

Upper half: Cell-cavities in "Prairie Berry" fruits. The numbers tell the number of cell-cavities in the respective fruits. Lower half: Color effect of eosin; 1, Yellow spots on carrot leaf; 2, Red rim on Pelargonium leaf.

EARLE J. OWEN, M.Sc.

Beans.

All experiments with beans the past season were confined to the area known as the "North Lot," occupying about one-third of an acre. They may be grouped as follows: (1) Snap bean crosses; (2) "Jackson Wonder" crosses; (3) "Scarlet Runner" hybrids.

(1) Besides the three selected strains of white-seeded snap beans, seed of which has been distributed, twenty-five crosses secured within the past two years were grown and notes were taken in regard to them. Most of these were represented by few plants and, with the exception of one or two, gave no records which merit discussion at this time.

The cross between "President Roosevelt," a pole bean, and "Crystal Wax-Davis" strain, as noted in last year's report, was continued from selected types which in most instances yielded well, the spreading plants with occasional runners producing stringless wax pods of excellent quality. Certain of the earliest plants (selected white-seeded wax) were harvested in time for a second crop which produced marketable pods the middle of October.

(2) "Jackson Wonder" Crosses: Along with the selected strains under observation since 1905, first generation plants were grown the past summer from white-seeded plants of new "Breeder sets" (1910), a repetition of the experiment begun in 1904, with the object of studying more in detail heredity during the first and second generations. To explain the term, "Breeder set," a cross between the "Jackson Wonder" and a white-seeded lima was actually obtained in the following manner: In the spring of 1910, seeds of "Fordhook," for example, were planted in a row, every alternate seed being "Jackson Wonder." By this method, when the plants were in bloom the bees were enabled to carry pollen freely from one variety to the other; but seed was harvested only from the "Fordhook" plants, since any crossing could there be readily detected by any colored seed in the crop harvested from the first generation plants.

Four of these "Breeder sets," — "Jackson Wonder" in union with the bush varieties, "Early Giant," "Fordhook," "Henderson" and "Station Bush,"—were grown; and at harvest time thirty-two plants were found with colored seed, seventeen of which were solid red and fifteen mottled. The mottled beans were confined to the "Jackson Wonder-Henderson" and "Jackson Wonder-Station Bush" sets.

The selected strains from the original crosses of "Jackson Wonder" with "Burpee," "Dreer," "Henderson," "Wood's" and "Station Bush," now in the seventh generation, were represented chiefly by the dark red and white sets, the condensed record below being a four years' comparison for these two strains of the per cent. breeding true to parent color, the five sets being grouped as one, with the total number of plants grown for each season.

	Number of Plants Grown.				Per Cent. Breeding True.			
	1908.	1909.	1910.	1911.	1908.	1909.	1910.	1911.
All crosses, dark red......	731	358	738	140	68.8	69.7	79.1	52.3
All crosses. white........	1,068	528	1,610	337	95.1	93.4	97.1	97.4

A glance will show that the white set has exceeded last year's excellent record by .3 of a per cent., while the dark red is 16.5 per cent. less than in 1908, which previously stood the lowest on the list. One reason for this low percentage in the dark reds is the fact that the separation of the dark from the light red is a difficult matter because of the shades coming between and not belonging to either group, so that if the two were classed as "solid red" the percentage for the four years would average much higher.

The "Jackson Wonder," selected dark, was represented this year by forty-one plants, 95.1 per cent. of which were similar to the parent in color, 3.3 per cent. more than in 1910.

(3) "Scarlet Runner" Hybrids, 63/43: For the past two years this branch of the work has been confined to selected strains of the offspring from the union of "Scarlet Runner" and "Tennessee" (63/43), the majority of the plants under observation for 1911 being in the seventh generation. About four hundred fifty plants of the "mottled gray" strain were grown this season, showing a uniformity of plant, flower and fruit characters worthy of a distinct variety and represented the result of selecting for six successive generations in the hope of securing the combination of a salmon pink flower and "mottled gray" seed.

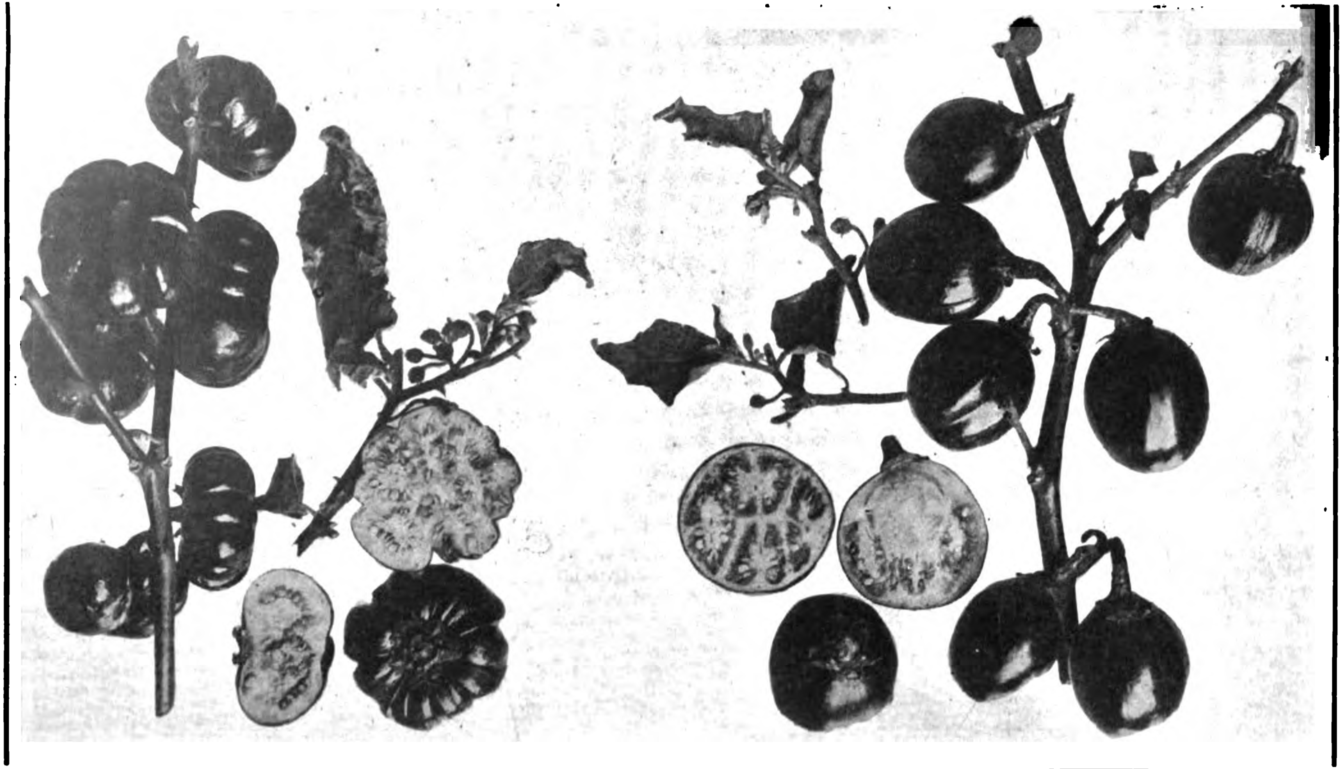


PLATE XXX.

"*Scarlet Chinese*" *Eggplants.* The ordinary form is shown upon the left; and the "Chameleon," upon the right.

Healthy and vigorous from the start, the plants were slower in their development than those of an ordinary bush bean, showing a strong tendency to spread and sending forth runners in some instances. The stems were dark or purplish and the compact foliage was composed of leaves similar to those of the "Scarlet Runner" in general appearance but scarcely one-third their size. The blooms were quite uniformly deep pink. The plants in question, while slow to set fruit, produced a good average crop and were ready for harvest the middle of September.

The short straight pods, averaging less than half the size of the "Scarlet Runner" parent, are stringy and not desirable as a snap bean, so that commercially this type has little or no value but proves the efficiency of continuous selection for a particular type of bean and represents a strain unique among its kind.

One plant harvested from the "mottled gray" set in 1910 showed a variation from the parent in its running tendency and remarkable productiveness, yielding 261 pods, seeds of which were pictured and discussed in the 1910 Annual. From these seeds over three hundred plants were grown during 1911, the majority of which were spreading in habit, late in season and possessed the parental vigor; but, though productive, failed to yield so abundantly.

All blooms were deep pink, the green pods being long, flat, curved and stringy.

Eggplants.

The eggplants, transplanted the last week in May, occupied Plots 2, 3 and 4 of Series III., and as a whole fell below the standard size of plant and productiveness, due largely to the unfavorable season. Eighteen commercials, including two novelties, were grown and comprised 124 individuals. Five crosses, two in the first generation, were represented by 131 plants, while 88 were classed as hybrids, since they contained the "Scarlet Chinese" "blood" in varying amounts.

The two varieties of chief importance from the breeding standpoint are those figured in Plate XXX., the "Searlet Chinese," because it is a parent of our present hybrids, and the "Chameleon," for the reason that new combinations are being obtained with it. The "Scarlet Chinese" on the left has been grown at the gardens for several years and needs little comment, while the “Chameleon” on the right was a field novelty in 1910, evidently a variety of the same species, *Solanum integrifolium Poir.* Both forms are similar in plant habit, the “Chameleon” averaging fewer blooms to a cluster (4.4) and being strictly spineless, in striking contrast to the “Scarlet Chinese” whose spiny nature is quite evident in the picture. The longer, smoother fruit of the “Chameleon” is well shown in the plate,—qualities which, together with the absence of spines, render it of greater value in breeding than its less attractive relative.

Concerning productiveness, “Chameleon” gave an average this year of 31.4 fruits per plant, while “Scarlet Chinese” yielded but 12.2 fruits.

Aside from the “Una set” discussed below, there is little to report at this time regarding the selected crosses. The two first generation crosses grown this season were “Ivory-Black Beauty” (26/4 I.) and “Ivory-Round Purple” (26/34 I.). All plants in both instances yielded purple fruits, those of the former cross (26/4 I.) being bell shaped and of good marketable size, while the latter (26/34 I.), though a good bearer, produced fruits similar to the “Round Purple” in size and shape which were too small to be of commercial value.

“Long White-Dwarf Purple” (11/6 II.) “Una Set:” Sixty-four plants in the second generation were given individual attention for a detailed study of plant, flower and fruit characters. They were slow in starting, due to adverse weather conditions, and few attained to their full development.

Some results from the tabular records are given below:

Purplish stemmed plants	52
Green “ “	12
Purplish fruited “	36
Green “ “	24
Ivory “ “	4
Spiny plants	64
Plants with pear-shaped fruits	41
“ “ oval fruits	11
“ “ fruit surface white under calyx	38
“ “ fruit surface greenish white under calyx	26

Three of the dominant characters—dark stem, dark fruit, and pear form—are inherited from the “Dwarf Purple” (female), while all the offspring possess the quality of spinoseness common to both parents.

The term "purplish fruited" includes the "greenish purple" and "violet" shades, each occurring in six instances. The fact that but 52 plants are recorded under fruit shape signifies that at the time of note-taking, the fruits of twelve plants were too small to indicate their form. The number of plants, the surface of whose fruits was found to be white beneath the calyx, corresponds closely to the record for purplish fruits, being 38 in the one case and 36 in the other. All but two instances of "greenish white beneath the calyx" are associated with a like color of fruit, the two exceptions being purplish green fruits.

The $\frac{7}{8}$ and $\frac{15}{16}$ hybrids did not hold their previous record for size and productiveness, the combination "Dwarf Purple-Scarlet Chinese" ($\frac{3}{4}$ "American") being the best yielder and averaging the largest fruits. A test of keeping quality for a period of more than a month which included most of the commercials together with the crosses, found two fruits of the $\frac{15}{16}$ "American" still firm and free from any decay (November 15th), the only variety to compare with them in soundness being "Striped." Notes on the remaining varieties and crosses (November 15th) described them as "decayed" or "badly shriveled."

In general it may be said of the hybrids grown thus far that the preponderance of "American" "blood" up to a certain point is beneficial and promises, with the growing of large numbers and care in selection, a desirable new sort both as a keeper and as a yielder; but too much of the "American" "blood" is apparently detrimental to size and productiveness with no gain in keeping quality.

"Scarlet Chinese-New York Improved" (I.), represented last year in the first generation by forty-four plants which failed to produce fruits with any seeds, was again grown this season, nine plants being under observation. They corresponded to those of 1910 in all points except vigor, averaging at harvest time about two feet less in height. The nine plants produced 89 fruits varying somewhat in size but were smaller than the "Scarlet Chinese," three having been found to contain a few seeds, so that hope of securing second generation plants for another year is entertained.

A new combination, "Chameleon-Ivory" (35/26 I.), was obtained in 1910, two of the four plants grown this season early showing the vigor characteristic of hybrid offspring, differing from 25/19 I. in a lighter foliage, narrower leaves and spinelessness. However, no fruit was produced so that continuation of this interesting hybrid is doubtful. An abbreviated record is given herewith comparing the offspring of these two first-generation hybrids with the parents in respect to size of leaf and number of flowers in a cluster.

	Leaves Measured.	Leaf Diameters.	Clusters Counted.	Flowers in a Cluster.
"Scarlet Chinese" (25)..	37	4.4 —12.6 cm.	34	8.6
The Hybrid, 25/19 I.....	113	6.02—16.04 "	289	7.4
"N. Y. Improved" (19)..	44	5.6 —14.3 "	52	2.4
"Chameleon" (35)	...	....	141	4.4
The Hybrid, 35/26 I.....	...	....	86	7.9
"Ivory" (26)	38	5.4 —14.04 "	121	1.8

In explanation of the "leaf diameters," the longer denotes the average length in centimeters of the midrib and the shorter the average diameter taken at the base of the leaf at its juncture with the petiole.

Novelties.

38. "Tomato:" To all appearances, it is identical with "Scarlet Chinese," doubtless being named from the fact that this eggplant, when mature, strongly resembles the tomato fruit.

39. "Marshall's High Bush:" A good late variety whose tall plants resemble "Florida High Bush" and yield medium sized, bell-shaped, purple fruits.

Okras.

Thirteen varieties of okras, seven crosses and the hybrid, "Golden Bowl-Okra" in its third generation, were grown in Plots 5 and 6 (New Acre) of Series I., including 312 plants altogether. The notes taken through the season, particularly at harvest time, have been condensed and placed in tabular form, two headings being omitted because of an incomplete record. Observations on plant height and pod length were not made until all growth was checked by frost, mature pods being selected for measurement.

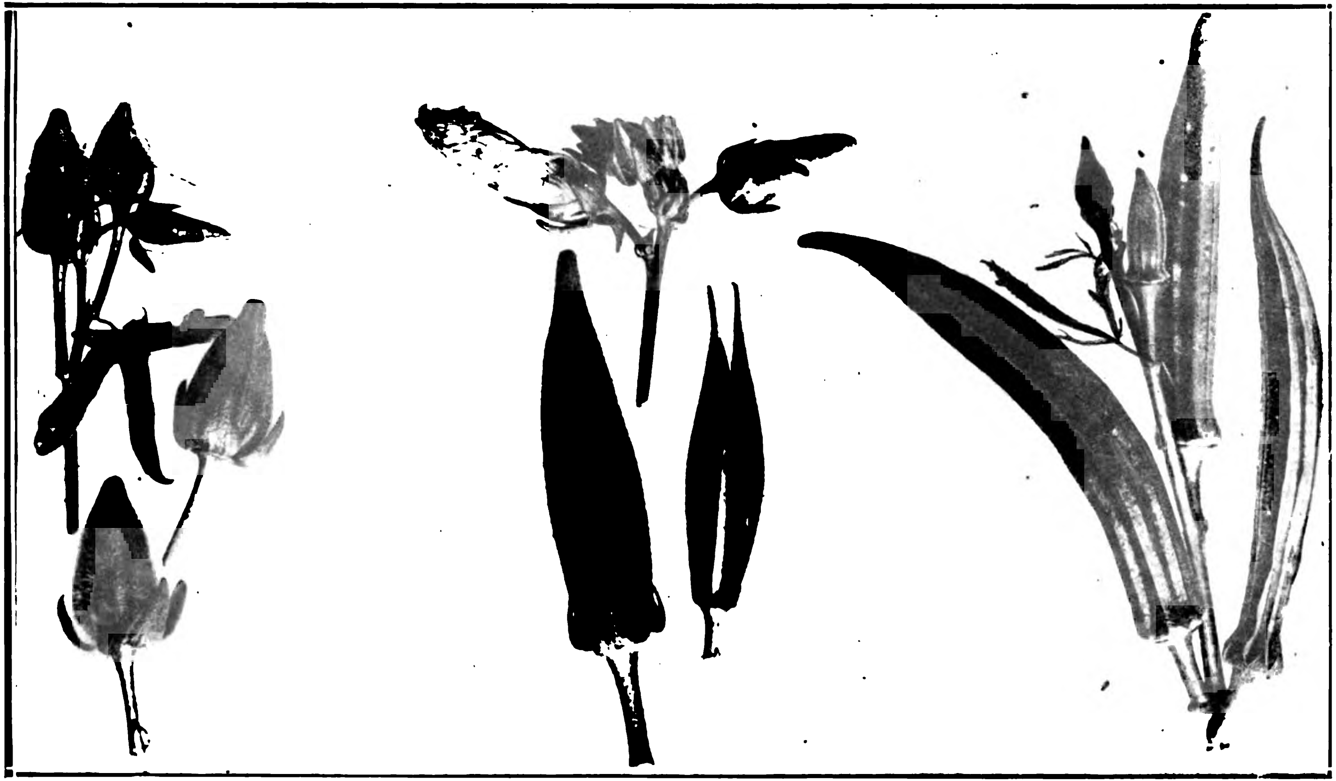


PLATE XXXI.

Okra. The pods of the "Golden Bowl" are shown upon the left; those of the common okra upon the right, and those of their hybrid in the middle of the plate.

Referring to column 2, the term "dwarf," as used commercially, appears not to correspond to length of stem, since "Dwarf Prolific" (1) averages only 23.5 cm. less than "Tall" (11), and "Dwarf White Velvet" shows a record of but 2.9 cm. less than "White Velvet." If dwarfness is associated with height, then "Perkins' Long Pod" (3), self fertilized 1910 (S. F. '10), comes nearest to being a true dwarf, having an average height of 53.4 cm., the lowest on the list. However, most of the commercials are not strictly true to type and greater care in selection and breeding is necessary to establish distinct and uniform sorts.

Measurements of the flowers were taken when they were fully expanded, "White Velvet" (8) and "Perkins' Mammoth" (13) giving the largest blooms (column 3); the smallest being found in the self-fertilized crosses of "Little Gem-Dwarf Prolific" (5/1). The heaviest yielder, as indicated in column 4, is "Perkins' Mammoth" (13), "Kleckley's Favorite" (2) being lowest in this respect.

Concerning pod locules (column 5), "Dwarf Prolific" (1) stands first for the commercials (8.8 cm.) and "Perkins' Long Pod-Dwarf Prolific" (3/1) has the highest average for the crosses (7.8 cm.).

TABLE OF OKRA MEASUREMENTS.

VARIETY OR CROSS.	Number of plants grown.	Average height of plant. cm.	Average diameter of flower. cm.	Average number of pods per plant.	Average number of pod locules.	Average length of pod. cm.
1. "Dwarf Prolific"	8	132.1	7.13	4.1	8.8	11.7
1. "Dwarf Prolific" (S. F. '10)	21	116.4	7.1	7.1	7.9	14.4
2. "Kleckley's Favorite"	5	84.7	7.28	3.8	7.0	11.5
3. "Perkins' Long Pod"	13	99.0	7.73	6.6	6.8	18.4
3. "Perkins' Long Pod" (S. F. '10)	8	53.4	6.96	6.5	7.3	18.7
4. "New Lady Finger"	10	99.6	7.38	4.4	6.9	19.34
7. "Perkins' Improved"	10	120.0	7.82	5.9	7.0	16.8
8. "White Velvet"	10	112.6	8.23	4.8	6.5	19.1
9. "Dwarf Green"	12	94.05	7.42	6.2	6.89	17.7
10. "Dwarf White Velvet"	8	109.7	7.52	6.5	6.5	21.05
11. "Tall"	9	155.6	6.98	8.5	7.9	12.3
12. "Wyrick's New Giant"	11	141.3	7.1	5.9	6.2	17.06
13. "Perkins' Mammoth"	11	116.1	8.15	10.0	6.6	19.6
14. "Mammoth Long Pod"	7	75.0	8.12	8.0	6.5	19.6
15. "Holt's Prolific Dwarf Early Green"	9	86.1	6.3	8.7	7.5	19.8
3/1. "Perkins' Long Pod–Dwarf Prolific"	9	73.8	6.42	5.6	7.8	15.5
5/1. "Little Gem–Dwarf Prolific" (S. F. '09)	17	107.9	5.83	6.9	6.6	16.06
5/1. "Little Gem–Dwarf Prolific" (S. F. '10)	13	112.3	5.18	8.05	7.2	17.2
6/7. "Long Green–Perkins' Improved"	16	73.4	7.3	8.7	7.1	16.6
8/1. "White Velvet–Dwarf Prolific"	17	133.6	7.76	6.5	6.8	18.6
8/6. "White Velvet–Long Green"	12	93.8	7.9	4.8	6.5	19.04
H. Manihot ("Golden Bowl")	12	85.1	10.51	7.2	5.0	.....
Hybrid, 3d generation	30	156.06	9.71	11.0	5.5	11.6
Okra averages	272	104.2	7.2	6.5	7.06	17.1

Comparing column 6 with column 2, it is seen that length of pod and height of plant are not associated, since the shortest plant (3 S. F. '10) bears a pod averaging 6.4 cm. longer than the tallest of all the varieties (11).

Turning to the record of the hybrids (*Hibiscus Manihot/H. esculentus,* third generation), an average for thirty plants finds them to exceed both parents in height and productiveness, and to be intermediate in respect to flower diameter and number of pod locules.

Owing to the immaturity of "Golden Bowl," the average length of pod was not obtained.

Plate XXXI. represents, together with the parents, the hybrid, "Golden Bowl/Okra," obtained in 1908 and now in the third generation. At the left is shown the male parent ("Golden Bowl") with the hybrid in the center and the "Okra," or female parent, at the right. Bud and fruit resemble more strongly the male while the calyx bracts are persistent until the pod matures and dehisces. In the "Okra" these bracts wither and drop soon after the pod forms. The downy hairs of the "Golden Bowl" become spines in the offspring, capable of penetrating the flesh and causing no little irritation. Dehiscence, a quality of the hybrid, is characteristic of both parents, although certain okra varieties, as the "White Velvet," possess it only in a slight degree.

Ornamentals.

Concerning the Pink hybrids figured in the 1908 Annual, *Dianthus barbatus/D. latifolius* has been the most striking of the group this season, the plants growing to a height of about two feet and producing a mass of magenta blooms for more than two weeks in June, some flowers being as double as carnations and nearly equal to them in size.

The other hybrids, *Dianthus Chinensis/D. barbatus,* for instance, seem lacking in perennial habit, only two plants of this blend surviving the winter, both producing sweet-scented blooms in abundance.

The perennial blend (F_1) of the Aquilegia cross continues its vigorous growth and wealth of bloom, flowering late after the manner of the popular "Chrysantha," one of the parent types.

The Pansy-Violet crosses have claimed attention because of their long continued free blooming habit, being still in flower late in October.

The "Rutgers" geranium has held its record of last year and a pleasing pink form of the second generation promises to become popular as a border plant or for indoors.

Limitation Experiments.

This branch of the work, begun in 1910, was continued this year with beans, eggplants, okras, peas and tomatoes, for the study of the effect of limiting the number of fruits borne by a plant, checks designated as "Full crop" being grown to compare with a second and a third group designated as "One fruited" and "No fruited," the terms explaining themselves. A portion of the "North Lot" was given over to this work.

The record under eggplants, okras and peas is too incomplete for discussion at this time.

Bean Limitation.

GROUP.	AVERAGE WEIGHT OF PLANT.		AVERAGE NUMBER OF BLOOMS PER PLANT.		AVERAGE NUMBER OF PODS PER PLANT.	
	Generation I. gms.	Generation II. gms.	Generation I.	Generation II.	Generation I.	Generation II.
"Black Valentine"—						
No pods	39.0	85.0	142.8	137.8	....	....
One pod	28.7	36.1	123.8	110.5	1.0	1.0
Full crop	14.8	19.8	20.8	17.6	18.7	12.07
"Davis Wax"—						
No pods	44.2	28.6	219.0	130.0	....	....
One pod	40.8	22.7	245.8	114.4	1.0	1.0
Full crop	25.1	11.07	219.0	130.0	15.0	7.8

Two crops were grown (Generations I. and II.), the long season being sufficient for the second to mature seed, "Black Valentine" ripening a little before "Davis."

The tabular notes (see above) record but three items of averages (others to be assembled later) and any comparison of the first with the second crop should be made with due regard to the fact that the second grew under less favorable conditions (August to November). In weighing the "one podded" and "no podded" plants, all the leaves were included as far as possible, which cannot be said in regard to the "full crop" group, as they matured before the other two and, consequently, dropped their leaves. There is a decided contrast in the number of blooms per plant between the "full crop" group and the others, but those of the "one podded" group bloomed as long and as freely as the "no podded." The greater plant weight is evident in the instances of limitation for both generations.

Tomato Limitation.

Group.	Average weight of plant.	Average number of flower clusters per plant.	Average weight of one fruit.
"Standard Stone"—			
No fruits	3773.3 gms.	126.4	.....
One fruit	4167.4 "	149.7	241.3 gms.
Full crop	1015.39 "	45.3	144.4 "
"Dwarf Stone"—			
No fruits	2482.8 "	77.6	258.9 "
One fruit	2460.7 "	84.0	119.7 "
Full crop	935.4 "	34.8	.....

The standard and dwarf "Stone" varieties were chosen for this year's work, thirty plants of each (ten in a set) being planted in rows two feet apart, following the same general plan as with the beans. Comparing the items under "Number of flower clusters per plant," those of the "one fruited" exceed the "no fruited" in both dwarfs and standards, while those of the "full crop" plants fall far below the other groups, being less than one-third the record for "one fruited" standards and less than one-half that for dwarfs. Under "Weight of plants," the "no fruited" exceed the "one fruited" in both instances, those of the "full crop" groups being much less again. As regards "Weight of fruit," since the one fruited individuals were necessarily few, it would be unfair to draw any conclusions from the figures at hand.

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REPORT OF THE ENTOMOLOGIST.

JOHN B. SMITH, Sc.D.

The winter of 1910–11 was a moderate one which did not break up as early as its predecessor and the spring was, on the whole complained of as two weeks late—a complaint which is borne out by some of the detailed records later. There was no flood of early moisture and, on the whole the season opened up very nicely until toward mid-summer when intense temperatures and drought complicated matters.

The office force after many years of satisfactory adjustment began to break up last year when Mr. John A. Grossbeck resigned to give place to Mr. Walter S. Abbott, of New Hampshire, in some departments of the Station work. The two men were not at all alike and, while both good, Mr. Abbott was not physically suited for the work I wanted done.

The outlet for Mr. E. L. Dickerson did not seem to offer a sufficent chance for a satisfactory provision in the Department, and I could not justifiably interpose to prevent his seeking a better paying position.

The result was that I faced in the winter of 1910 and at the very beginning of the season of 1911 a disorganized department, or one dropping into disorganization.

I was notified by Dr. E. B. Voorhees, Director of the Station, that I might strengthen the College Department of it by the appointment of a formal assistant in technical work, and this permission was met by the assignment of Mr. E. W. Stafford, of the Minnesota Station, to orchard work, particularly the plum curculio. Mr. Stafford entered on the duties of his position February 1st and continued in service throughout the summer. [redacted] Such work as he accomplished will be found recorded here.

Mr. Abbott's limitations were mostly physical and his entomological work was good and appears chiefly in the preceding report. His assignment had appeared on the mosquito section of the State organization, and his work in the purely entomological section was merely incidental, though interesting and important.

The work of the State Entomologist, involving as it does the work of the horticultural inspector, is becoming ever more important, and it is due to the State that this branch be made as strong and as self-supporting as possible. As Mr. Dickerson, who had occupied the position of assistant for many years, had qualified himself for better paid work, and as there had been some addition to the appropriation for the position of State Entomologist, I secured authority from the Executive Committee of the State Board of Agriculture, through the Civil Service Commissioner, for an assistant in nursery inspection work to help out in lines that Mr. Dickerson had not found it possible to take up heretofore.

Mr. Dickerson's final resignation came before the inspection season was over; but fortunately not until he had been able to introduce Mr. Harry B. Weiss, his successor to the nursery business of the State, and I believe our work will go on as quietly and efficiently as before the change was made. My unfortunate attack of illness has thrown practically all the field work on Mr. Weiss for a time and has left me only the routine and office work to look after.

Further administrative details of the office of State Entomologist do not belong here, of course, but the entomological work of this State is so closely associated that it seems in place to record here that the nursery situation is in better control than it ever has been, and that we have cleaner and better stock than ever before in our history.

Foreign Stock.

Foreign stock is much better supervised than ever before; very little of it gets into the State through the Custom House Ports of Entries, of which we do not get notice, and not a dealer escapes question or examination. The amendment of our law at the last session of the Legislature has had a very good effect upon a great many of our shipping agents, and it has made a material difference in the practice of some of the foreign shippers. The character of the stock is distinctly better, it is distinctly cleaner, and the for-other than his own in the matter.

In my report to the State Board of Agriculture I called attention to the enormous New England trade, over which a rough supervision was kept last season, and which, in a way, is being looked after this year; but this New England danger has not in all respects disappeared and still has a potential existence.

Gypsy and Brown Tail Moths.

It is not believed that there is a single living example of either of these species, at large, in any stage, anywhere in the State of New Jersey at the time of writing the above. During the summer there were more alarms than usual owing to the number of species that were mistaken for the pests; but every investigated case gave us a little additional assurance of safety, since it assured us a closer lookout and a broader general interest.

Of course, the area where the species was introduced in 1909-10 was kept under observation, and the New York authorities were, apparently, as greatly interested in the matter as we were. But besides our own men, I had Mr. Rogers assign one of his most reliable scouts onto the job, and his report to me was in all respects thorough and satisfactory. I feel absolutely certain that no slip took place here, and that the entire infestation, such as it was, was completely wiped out.

Nor do I feel that at any point where the insects had come in on nursery stock they have made their escape and have established themselves to any degree whatever.

At present, if any centre of infection exists, it is one that has never come to my attention at all, and it will be one in some altogether unlooked for or unexpected point.

And whether such an unlooked for or unexpected point will not be one due to a natural spread is at least a question.

Natural Spread.

This matter of natural spread in the New England States is of ever greater importance, and there is no doubt that, especially the Brown-tail moth, is so widely and so generally spread about that its normal. In covering miles upon miles by auto, losing track of the species altogether for a time, picking it up again here and there in the most unexpected way, running across a few isolated examples, without reference to any others so far as information goes—all this gives an air of unexpectedness to the matter that would lead one to accept almost the most unexpected occurrence without any surprise. It has almost created a feeling of expectation that seems to await satisfaction, especially along the New York border.

Massachusetts Visit.

During my usual summer visit in 1911, in company with Mr. Rogers and Mr. Worthley, the chief impression that was given me was that of success—a conviction that the insects were under control. There was a feeling of confidence that, no matter what happened, the insects would not be permitted to get the better of the organization, and that the organization had all the necessary power to deal with the insects. There was not, however, any under-valuation of the force of the insects or any illusion as to their power to spread or cause injury. Simply the feeling of power that comes from a knowledge of the problem from all sides and a confidence in the ability to handle it.

It was perhaps the chief difference in the attitude of the office at large to the problem—less uncertainty and less helplessness even should the worst occur, and that, I believe, will, in itself, prevent any worst from occurring, because when the insect does seem to get beyond our control, it will be in seeming only, and there will be so many, many methods actually in use that there will be no real worst to come.

Bee Inspection.

Another piece of legislation that added to the burden of the Entomologist is the following, which forms chapter 60 of the laws of 1911:

An Act to supplement an act entitled "An act to prevent the introduction into and the spread of injurious insects in New Jersey, to provide a method for compelling their destruction, to create the office of State Entomologist, to authorize inspection of nurseries and to provide for certificates of inspection," approved April fourteenth, one thousand nine hundred and three; to provide for the inspection of apiaries and for the suppression of contagious or infectious diseases among bees.

BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. It shall be unlawful for any person, firm or corporation to have or keep in his or their possession or in any apiary, any colony of bees infested by the diseases known as American foul brood or European foul brood or by any other disease which is contagious on infectious in its nature and injurious to honey bees in their egg, larval, pupal or adult stages, and any person, firm or corporation so having in his or their keeping or in his or their possession any colony of bees so infested, after notice of the existence of such disease given as hereinafter provided, shall become and be subject to a penalty of twenty-five dollars, to be collected as hereinafter provided.

2. It shall be the duty of any person, firm or corporation in the State of New Jersey who is engaged in the rearing of queen-bees for sale, to have his or their apiary inspected at last twice during each summer, and it shall be unlawful to ship from such queen-rearing apiaries any package or parcel containing queen-bees without having attached to it a certificate from the State Entomologist, giving the date of the last inspection, and containing the statement that the apiary in which such queen-bees were reared was, at the time of such inspection, free from American or European foul brood, or other discoverable contagious or infectious disease. Any person violating the provisions of this section shall be liable to a penalty of fifty dollars, recoverable as hereinafter provided.

3. It shall be the duty of the State Entomologist, designated as provided in the act to which this is a supplement, by himself or by a deputy appointed as provided in said act, to investigate, or cause to be investigated, all apiaries or other places where bees are kept or raised in New Jersey, and to study and investigate, or cause to be studied and investigated, outbreaks of bee disease and other conditions unfavorable to the development of bees within the State. It shall also be the duty of said entomologist to investigate all complaints of the existence of disease of any kind in apiaries or other places where bees are kept, and to inspect or cause to be inspected at least twice in each season, when requested by the owner, all apiaries where queen-bees are reared for sale. It shall further be the duty of said State Entomologist, whenever he finds any apiary where queen-bees are raised free from foul brood or other discoverable infectious or contagious disease, to furnish the owner of such apiary with a certificate stating that fact, and such certificate shall state the date beyond which it will not be effective.

4. Whenever in the course of the inspections or investigations made or carried on as provided in this act by the State Entomologist or under his direction, said State Entomologist shall become aware of the existence of

any apiary or colony of bees, it shall be his duty to notify forthwith the owner or owners or manager of such infested or diseased apiary or colony, of the character of the infection and of the means to be taken to treat the same for the eradication of such disease. Said notice and order for treatment shall be in writing, and the directions for treatment may be written or printed, and may consist of a bulletin or other publication of the New Jersey State College Experiment Station. Said notice and order for treatment shall also specify the time within which the prescribed treatment must be made, which shall not be less than eight days after service of the notice or order upon the owner, owners or manager of the apiary or colony. And in case of doubt, where the presence of disease is suspected but cannot be definitely determined because of the character of the hives used, said State Entomologist may, in his discretion, order any owner of bees in box hives without movable frames, to transfer such bees to movable-frame hives to facilitate inspection and supervision. It shall thereupon be the duty of the owner, owners or manager upon whom such a notice and order is served, to comply with it in all respects within the time limited in said notice and order, and in case of a failure so to comply, such owner, owners or manager shall be liable to a penalty of twenty-five dollars, recoverable as hereinafter specified.

5. It shall be unlawful for any owner or other person having diseased bees or their larvæ, or infested hives or combs, or other appliances or utensils for keeping bees, to expose, sell, barter or give away or allow the same to be moved, until after treatment as prescribed by the State Entomologist, and it shall be unlawful to expose, sell, barter or give away such infested bees, larvæ, hives or combs or other appliances after treatment, until such materials are declared safe and permission is given by the State Entomologist or his deputy. Any person offending against the requirements and provisions of this section shall be liable to a penalty of fifty dollars.

6. In case the State Entomologist or his deputy shall find any apiary or colony of bees, in his opinion, so badly infested by American or European foul brood or other infectious or contagious disease that he shall deem it necessary to order the destruction of some or all of the hives, combs, bees, larvæ or other material as part of the treatment, and the owner, owners or manager of such infested apiary or colony shall dispute the diagnosis made by the State Entomologist or his deputy, or the necessity for the destruction of the hives, combs, bees, larvæ or other material, it shall be the privilege of such owner, owners or manager to appeal within three days after the service of the notice and order upon him or them, to the committee of appeal provided for in section twelve of the act to which this is a supplement, and the proceedings of such appeal shall be in all respects as provided in said section. Said committee of appeal shall have the same power to reverse, modify or confirm the order of the State Entomologist made under this act, that is conferred upon them in the act to which this is a supplement.

7. Any person who offends against the provisions of this act and becomes liable to the penalties prescribed in any of its sections shall be prosecuted as prescribed in section fifteen of the act to which this is a supplement, as amended by chapter forty-seven of the laws of one thousand nine hundred and four, approved March twenty-second, one thousand nine hundred and four, and if the order of the State Entomologist commanded the destruction of any bees, larvæ, hives or combs, or other utensils or material used in keeping bees, the judgment of the court imposing the fine shall include also an order to the officer enforcing its judgment to seize and destroy the specified colonies of bees.

cordance with said order, which the said officer shall thereupon be fully authorized to do.

8. For the purpose of making the investigations and inspections specified in this act and to enforce the provisions of the same, the State Entomologist or his deputy shall have free entry upon or into any apiaries or premises where bees are kept, or infested hives or combs are stored, and any interference with or obstruction made to the entomologist or his deputy while engaged in the performance of the duties herein imposed shall subject the offender to punishment as a disorderly person under the general laws of the State, upon a charge made against him by the officer interfered with.

9. The sum of two thousand dollars annually is hereby appropriated to the State Board of Agriculture for the purposes of this supplementary act; *provided,* that no payment shall be made pursuant to this supplementary act until the amount thereof shall have been included in the annual appropriation bill.

10. This act shall take effect immediately.

Approved March 28, 1911.

The Committee on Appeal, appointed by the Executive Committee, is Franklin Dye, Secretary of the Board; Mr. Elias Black, of Little Silver, a member of the Board and of the State Board of Horticulture, and Mr. Albert S. Repp, a member of both boards and of the Executive Committee of the State Board of Agriculture.

The bee legislation was the outcome of a long series of attempts by the bee-keepers of the State to control the spread of foul brood; but heretofore the attempt has been made outside the organized Agricultural Societies, and has been open to the suspicion that there have been selfish motives back of it. By turning the whole matter over to the State Board of Agriculture, with the remainder of the Entomological Inspection work, this subject was put on a proper basis and no serious opposition was encountered.

The bill carries an appropriation of $2,000, and $1,000 was made available for the fiscal year ending October 31st, 1911. Under the Civil Service law, Mr. Charles S. Sharp, of Newark, New Jersey, was appointed deputy July 1st, 1911, and served for the balance of the year, when he resigned to accept a better commercial position.

During the three months of his service the information secured justified the inspectorship in every way. There is scarcely a locality in which foul brood, European or American, was not found, and no point where bee-keepers were not in need of information and assistance. It is probably too much to say that New Jersey is in worse condition, so far as its bee industry is concerned, than surrounding states; but it is certainly in no better shape and needs all the assistance that the State can give under the legislation already enacted, heartily backed by its organizations, to maintain the commercial industry and the natural advantage that the bees offer our horticulture. This is a topic that is bound to become important, from the horticultural standpoint, and that must become somewhat prominent in our short courses and farmers' institute work. It is on the State side that it will require most attention then and where details of conditions found will be recorded.

Cut Worms.

With so large a variety of cover crops, and so many trucking plants, the matter of cut worms will always be an important one in our State, and not always the same for several years in succession. This year, for instance, cover crops, like clovers and alfalfa, have suffered out of all proportion to conditions in previous years, while the truck crops, that have in some other seasons found reason for serious complaints, have hardly been reported on the troublesome list. It has been the late fall list, in fact, that has been the source of trouble in 1911 rather than the spring list. Something we must expect to bear each year with more or less philosophy, for almost invariably something must be neglected. Late injury to alfalfa is one of those things that as a rule can be borne since no permanent harm is done and only a temporary feeding on a certain amount of forage is suffered. It is not always realized that this late feeding is not always dead loss either, because there is nearly at all times concealed with the source of trouble the parasite or source of remedy for it. It has been so in almost every case investigated by us this fall.

Insecticides.

Practically nothing was done with insecticides during the year just passed that I am in condition to report upon just now. A very large number of experiments were made by Mr. Weiss in the course of his greenhouse work at Riverton; but this was planned on a large scale and should be reported upon in a comprehensive manner.

During the several years last past that I have been engaged in the work of inspecting greenhouses, not only in the State of New Jerbulk of all the work that is done indoors, under glass, for the destruction of injurious insects is wasted and might as well be thrown away altogether. Much of the work done in nurseries is of the same character and there appears to be a perfectly enormous field practically new and almost virgin in its character.

In selecting Mr. Weiss as my assistant in the work of the State Entomologist in New Jersey, I kept in mind this feature, and one of his main qualifications originally was a knowledge of chemistry that would help in this line rather than the more general inspection work that he was later called upon to undertake. However, for a period of several months Mr. Weiss spent his time in the greenhouses very largely; in collecting and familiarizing himself with the foreign and other species to be dealt with and in becoming in all respects fully acquainted with what may be called current nursery practice against usual nursery pests. He is therefore fully up to date on these points, and has reported in considerable detail the practice and effect in perhaps the majority of State practice.

This forms a bulk of material to draw upon for further experimental work that is really not yet open and will form a foundation for the most valuable kind of work ever done in the Eastern United States, so far as greenhouse work is concerned.

Room for hap-hazard experiments there was none in this scheme, and therefore whatever insecticides have come to us have been classified and arranged for such use as might seem indicated in the general work to be carried on.

Field work has not been done to any considerable extent with insecticides. The character of the work laid out has been against it and the opportunities have been against it. It is no part of the Experiment Station work merely to try out materials for the benefit of manufacturers, particularly when there is no certainty that these materials will be put on the market afterward or maintained at a standard at which they are tried. Therefore, a recognized chemical commercial combination, like arsenate of iron, is a legitimate material for experiment, but Smith's carbolic destroyer is not, although, as a matter of fact, the latter may be a very useful sort of material indeed for a limited purpose or a temporary difficulty.

Strawberry Weevil.

This insect found the season much to its liking and was extremely troublesome, not only in the territory heretofore covered by it, but much further north; extending into Burlington, Gloucester and Camden counties. Even the wild strawberry plants at Vineland were found to be infested and scarcely a field escaped trouble of some kind.

Up to the present time the growers do not seem to be inclined to modify their practice or to select varieties not subject to attack, preferring rather to stand the injury and hope for better things in the future.

Mr. Blake, in the Horticultural Department, however, expects to take up the matter from this point of view in the hope of securing varieties that will be satisfactory as to crop and quality as well as resistance to these insects. Nothing new has developed in the way of a practical method of destroying the insects or avoiding damage.

Asparagus Beetles.

Both species were very much in evidence early in the season, and in the more southern parts of the State in approximately equal numbers. Further to the north the older species (*C. asparagi*) was much the more abundant and, north of the red shale line, the only species. It was interesting to find that greater injury than ever before was reported from the most northern points which had, in the past, suffered but little.

The growers in Monmouth, Burlington and other southern counties have learnt pretty generally that the arsenate of lead, carefully and thoroughly applied after the cutting season is over, is a reliable and effective check to both the species, and that little injury need be suffered where the application is made before the first brood of larvæ gets much of a start. One pound to 10 or 15 gallons of water, depending on the strength of the arsenate, is recommended.

Harlequin Cabbage Bug.

It is many years since there was opportunity to record this species from New Jersey, and even now it is sent in only by Mrs. E. S. Starr from the vicinity of Ocean View in Cape May county, as if it didn't really belong there.

As a matter of fact the only time that the insect really did get a good foothold in the State was in 1906, and that occurrence was recorded in Bulletin No. 121 of the Experiment Station. It disappeared almost or quite completely since that time and certainly has not again re-appeared as an injurious form.

Plant Lice.

Plant lice were not much complained of during the season, and that was especially true of those infesting trees; but in midsummer some complaint came from Burlington county, where it was said hundreds of acres of tomatoes were infested in early July. Mr. Weiss was assigned to the field with instructions to find whether other Solanaceous families also shared in the attack.

Mr. Weiss began his investigations at Moorestown on July 11th, and found that the lice began to be prominent on tomatoes about the first of that month, increasing very rapidly on all plants of the Solanaceous families until about the 8th, when these seemed to be literally millions of them on hundreds of acres, chiefly on tomatoes.

At about the time they seemed most threatening, however, some adverse condition seems to have intervened, and conditions now seem almost as favorable as ever for the plants. There were still plenty of plant lice, but most of them were dead or dying, drying up on the vines; with numerous parasitic and predatory foes of various descriptions among them and rapidly reducing them in number.

The Garden Web-Worm.

Eurycreon rantalis.

This is an insect that once upon a time played tricks in a great many of the Central and more Southern States, and under its common name of "the garden web-worm" obtained rather an unpleasant reputation. In New Jersey it was rarely found and practically not at all troublesome. So little, in fact, that I did not have it represented in my series of injurious forms, and did not recognize it when it was sent in during September as appearing suddenly in great numbers in an alfalfa field at Center Square.

I sent at once to Center Square on September 19th, and Mr. Patterson reported that the full grown caterpillars as present, not only in considerable numbers feeding upon the alfalfa, but also upon lima beans, and that for twenty feet the lima beans had been as completely destroyed as the alfalfa. Clover in a nearby orchard had not been attacked, nor had other alfalfa plants in the immediate vicinity; but throughout the alfalfa field in general there was quite an infestation, and at one end the plants had been almost defoliated.

At the time that the investigation was made the caterpillars were active, vigorous, just about full grown, were busily engaged in spinning their webs, and their general character as a *Pyralid* and a member of the Botid group was sufficiently obvious. Yet somehow or other the insect did not thrust itself upon my remembrance, and it was allowed to go into the breeding jar and into the pupal stage without being recognized. During the middle of October, when an adult was bred the recognition was immediate, and the comedy of errors was at an end.

There is no species involved here that has suddenly adapted itself to feeding upon alfalfa, but simply this miserable garden web-worm has added one more to its ordinary range of food plants, which it will take in whenever it becomes abundant for any reason.

It is very curious that this should have been the only case of this kind that has occurred within the State up to the present time of an attack upon alfalfa by so well known a general feeder, or by cut-worms in a general way. So vigorous a grower and so attractive a plant would seem scarcely likely to escape an attack of this character. I must confess, however, that the attack by this garden web-worm was altogether unexpected, and looks like a good deal of an absurdity.

Blister Beetles.

Blister beetles or *Meloids* are comparatively few in number in the Eastern United States so far as species are concerned, although some of them are very numerous in specimens; the latter occurring chiefly late in the season and being of types such as those known as the old fashioned potato beetle, and some of those species that are found on late blossoming flowers in the gardens. In the far west the number of species is abundant as well as the number of specimens, but the insects there form a distinct feature of the beetle fauna of the country.

It very rarely happens that a few of the species that occur with us in the early part of the season occur in large numbers, and when that does occur it is usually a matter of only a day or two, and a matter of very large numbers.

The season of 1911 was one of those when species of this character were common, and not only in the State of New Jersey but also in the neighboring States of New York and Pennsylvania flights occurred of species of *Pomphopœa,* which for a day or two entirely covered peach orchards, and seemed for the time being to threaten the crop itself; but in every instance the invasion seemed to have lasted for a single day only, and the specimens that were sent in by the correspondent with the first communication were all that could be obtained. Invariably a letter sent by return mail and asking for additional specimens was answered by the statement that the insects had completely disappeared, and that no more of them could be found. It is a curious fact that this is one of the group of species where it appears as if all the insects of an entire brood came to maturity on identically the same day, and exactly the same conditions seemed to bring them all out at one time. They make their appearance, get their food supply, mate and lay their eggs and disappear—all within forty-eight hours—coming like a nightmare and causing a threat that is never carried out. We have in our local fauna just two species which make their appearance under conditions of that kind. The others are more or less annual visitants, in smaller numbers.

Trioza tripunctata Fitch.

This is one of those species which the collector seems to find common enough in winter on pine trees, and which seems to breed in summer on deciduous plants of an altogether different character.

As far back as 1869 it was found troublesome in New Jersey by Mr. Charles Parry, of Cinnaminson, on blackberry, and then Mr. A. S. Fuller, in 1880, read a paper on the insect before the New Jersey State Horticultural Society. Mrs. Mary Treat, of Vineland, also in New Jersey, described the species in 1887, and Dr. Riley wrote concerning it in the American Entomologist.

Heretofore it was always in New Jersey, and on the blackberry that the insect had been troublesome; but in 1893 Mr. F. A. Sirrine found it injurious on Long Island, and wrote us more concerning it in the Report of the Entomologist of the New York Agricultural Experiment Station. He wrote a brief account of the egg-laying habits and something concerning the injury caused on the vines, and he gave a suggestion as to how the trouble might be avoided.

In 1910, Mr. George W. Blodgett, writing from Lakewood, sent a badly distorted blackberry shoot, with a request for information which there was nothing at the time on the specimen to enable us to give him.

June 15th, 1911, another sample of distorted blackberry shoot was sent in; it was determined that this was probably of insect origin, and Mr. E. L. Dickerson was assigned to visit the grounds June 23d. He found them in the heart of the pines, toward the ends of a few rows in a clearing, and that the upper and newer shoots of almost every plant were distorted and twisted out of all semblance of normal growth. The extent of infestation was somewhat greater than it was in 1910, but there is no record of similar infestation. The old injured canes had become completely curled around and had masses of dry leaves attached to them.

An examination of the collected material showed numbers of the characteristic eggs attached to the curled hairs and, to some extent, on the upper as well as the underside. In some of the curled leaves recently hatched nymphs were also noted, but only a few

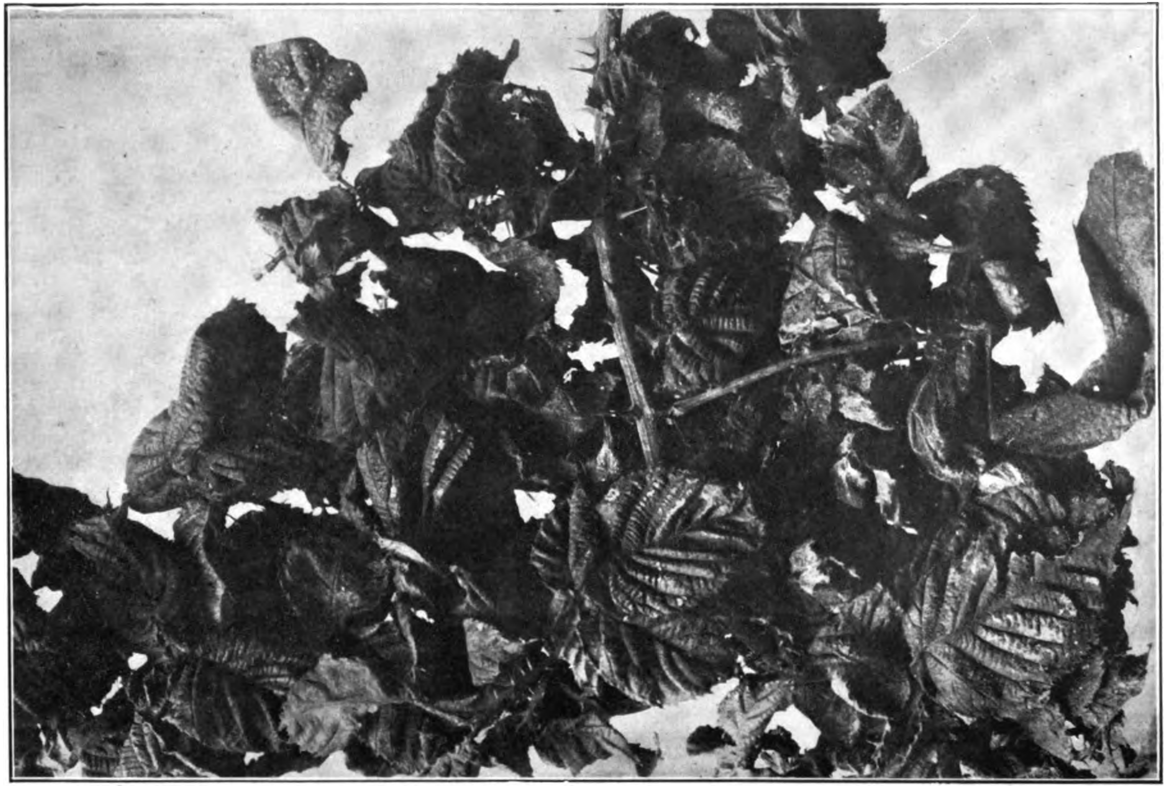

Figure 1.

Bramble flea louse. Shows crippling of the foliage by the insect. From an original photograph.

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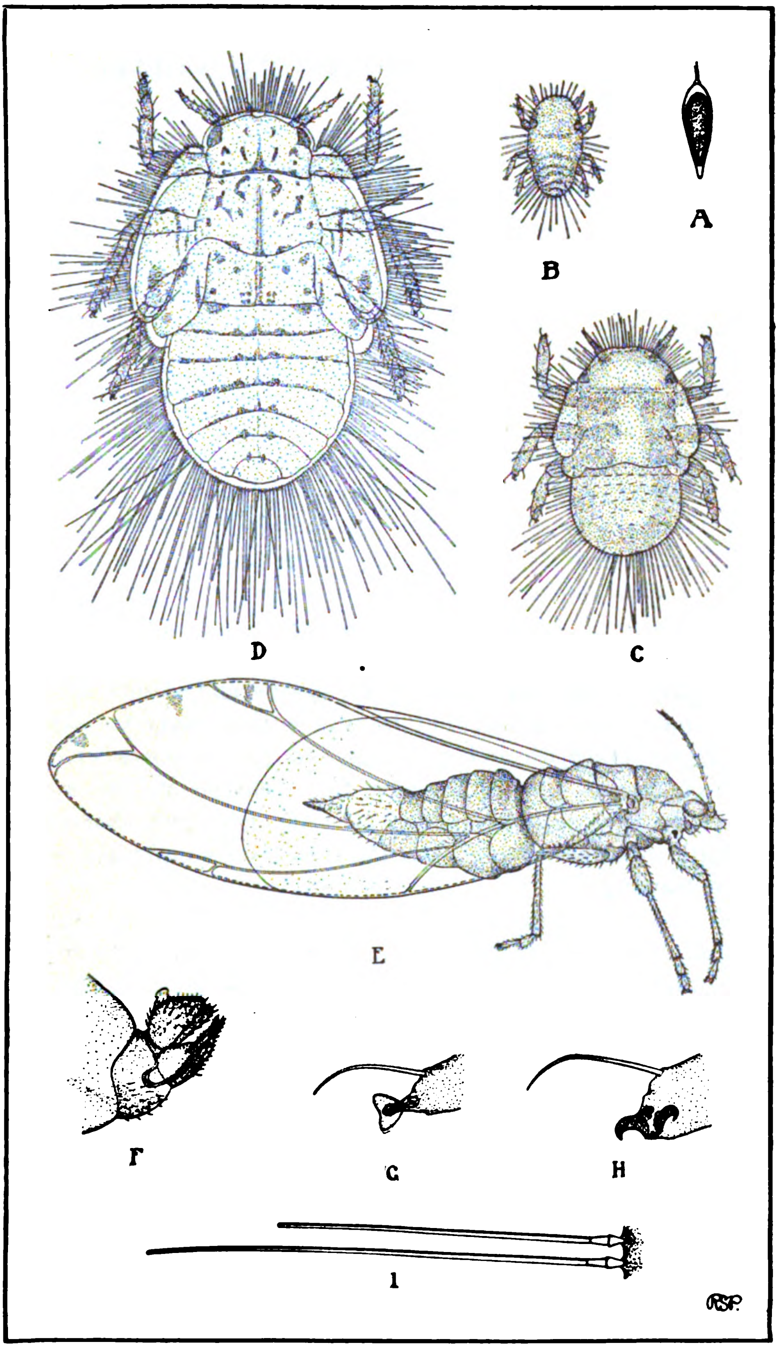

Figure 2.

Bramble Flea Louse. *Trioza tripunctata.* Fitch.

A—Egg on peduncle.
B—First Nymphal stage, found June 23d.
C—Second Nymphal stage.
D—Third and last Nymphal stage.
E—Adult, female, found September 25th.
F—Genitalia of male.
G—Tip of leg of first Nymphal stage, showing sucker disk.
H—Tip of leg in second and third stages, showing claws.
I—Wax hairs from Nymphs, showing the secretary glands. All greatly magnified.

to the character of the species that we had in hand.

July 19th, Mr. Dickerson was again at Lakewood and found conditions very little changed. There had been no obvious spread to new plants and the infested plants were not much worse off. On some canes the shoots were shorter and more bunched and more infestation was noted in those curled leaves. At the growing end and upper part of the infested canes some of the leaves, especially on the underside of the curved or infested canes, were more or less curled and developing abnormally. But at the tips or on the upper parts of the canes I could find little or nothing in the way of infestation. There were no adults on the vines at this time, and the adults developed in the laboratory very slowly.

All the insects were in the early stages and all had the jointed, waxy threads that are so readily broken off and give the surface of the leaf its characteristic powdery material appearance.

Now, here the office observations are incomplete and unsatisfactory. Mr. Dickerson collected the insects and should have kept them under observation; but he was getting ready to leave, was closing up his notes and workings and was finishing up the inspection work. I ought to have taken charge and assigned his work; but my own illness kept me away from the laboratory for a month continuously, and Mr. Patterson was simply instructed to make drawings.

We have no records therefore of the length of time during which the insects remain in the various stages except that growth is very slow, that the adults do not appear until September, and we do not know why or under what conditions they go to the Pines.

As to the character of the injury caused, Mr. Dickerson writes: "The curling of the uninfested leaves I believe to be due to something other than the direct injury of the insect. It may be that the tissues of the infested and curled canes were so poisoned by the early feeding of the adults that these canes cannot get the proper nutrition nor mature properly. It is to be noted that the distorted and malformed leaves come on the upper part of the cane or on the underside. I cut open some of these curled canes, but could find no evident injury to the tissue.

Remedial Measures.

As the adults obviously come on the blackberry vines early and cause their distortion by feeding before laying their eggs, injury to the endangered plants can be prevented by spraying with kerosene emulsion as soon as the first adults are seen.

If this is not done it will be possible to wait until all the eggs are laid, and about the time they are beginning to hatch, cut back to sound wood and destroy all trace of malformation or of the area where eggs are laid. The entire subject is so characteristic and peculiar a one that it does not seem possible that it can ever be of wide-spread importance.

Apple-Leaf-Hopper.

Empoasca mali Le B.

This leaf-hopper again made its appearance in the Barclay orchard near Cranbury in destructive numbers, and in some other places in the vicinity in somewhat smaller quantities. It is always rather plentiful as a matter of fact, and the discolorations on the leaves of the younger trees after mid-summer always indicate the presence of a considerable crop of them; yet it is rather exceptional to find any real impairment of the crop due to the feeding.

Mr. Dickerson was with Mr. Blake on the Barclay orchards, June 8th, and there was no doubt of the impairment of the vitality of the foliage in spite of the spraying that had been done. Egg punctures were also found in some numbers, but the eggs seemed in poor condition, and few of those brought into the laboratory developed normally. One pound of fish-oil soap in 8 to 9 gallons of water had been used, and there is no doubt a good result was obtained; for later in the season the insects were materially reduced and did not, in September, when I saw the orchard, make a bad showing in it.

On several occasions during the summer I had opportunity to observe accumulations of these leaf-hoppers, and there is no doubt in my mind that the amount of injury actually caused by them is scarcely appreciated. This applies not only to the particular species here under consideration; but to leaf-hoppers in general.

Apple Bud Moth.

This is not a species which under ordinary circumstances is troublesome in the State of New Jersey, and is not one against which applications are usually recommended. It makes its appearance quite early in the season, and where it does occur often causes a great deal of injury to the fruit crop. For the first time reports were brought in this year by E. W. Stafford and by Edgar L. Dickerson of bud moth injury at Trenton and High Bridge in the apple orchards at those points. The insects were not abundant at either place; but they were quite noticeable and enough of them were collected to make certain of the species, and to determine the fact that the insect was really a factor in our orchards, and might, under certain circumstances, become a dangerous one. It behooves apple growers to keep a lookout for the species, and if anything more is noted.concerning it in other years to bring the matter to the attention of the Station, so that such investigations as may be indicated may be made and the New Jersey practice determined upon. It is hardly likely that the insect is apt to be as dangerous and as injurious as it is in some of the more northern orchards.

The Common Plant Bugs.

Capsidæ species.

Not a factor of the species that the Entomologist sees on the plants that come under his observation during the summer does he pay more than the slightest or most cursory attention to. He may and often does realize an interesting life history slipping away from him here and there; but he realizes that the number of such happenings is out of all proportion to his ability to attend to them and that very frequently an entire group of species may take part in an attack or a series of attacks that would require years to work out.

So is that series carried on by the so-called Capsidæ or common plant bugs, species in which some entrance has been made of recent years and which have in common the puncturing of the leaf and fruit tissue of apple and allied fruits, and the resultant injuries from either egg-laying or feeding punctures at one or more stages of growth.

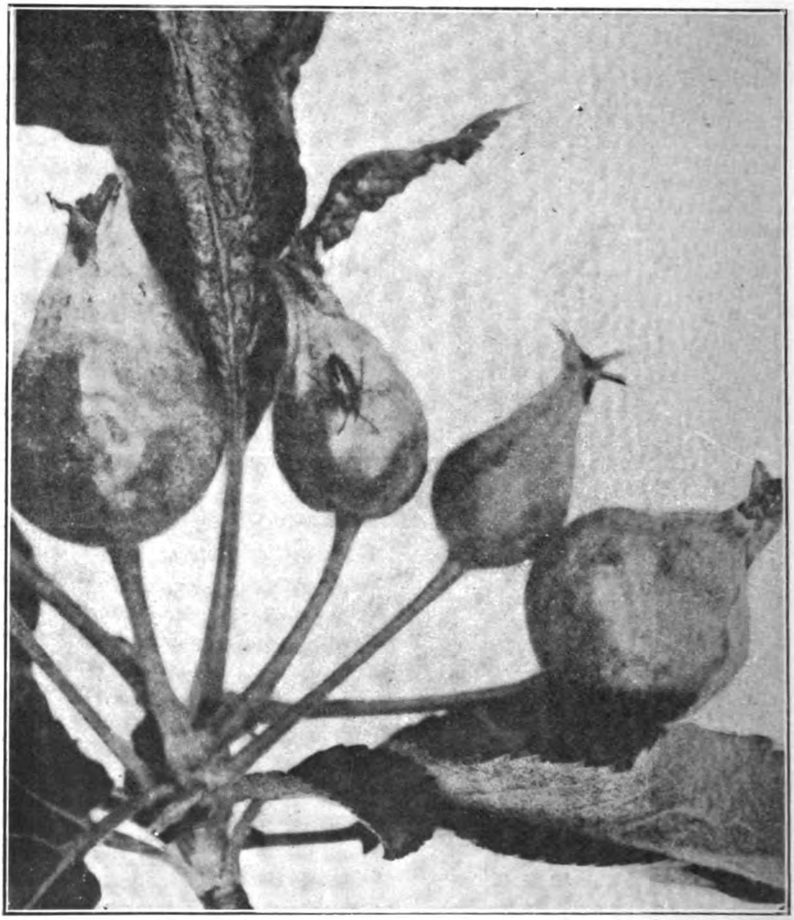

Figure 3.

False Red Bug; its work in New Jersey Apple Orchards; enlarged. From original Photo by Mr. Blake.

Quite a variety of species of Capsidæ have been brought in by the field agents and by Mr. Blake and his assistants, and in every instance where there has been any observation or study made there has been that tendency to dimpling and to the puncturing of the tissue resulting in the distortion and injury. The relationship is not always so entirely simple either; because in many cases there may be more than one economic species involved and a dependence upon a small fruit in one stage does not always nor altogether prevent a dependence upon a large one in another.

The False Apple Red Bug.

Lygidea mendax Reut.

During the summer of 1911 Mr. Blake brought in from time to time some peculiarly knotty apples, and others, of the office force observed and recorded similar specimens from various portions of New Jersey. Bulletin No. 291 of the Cornell University, issued in January, 1911, identified these abnormities as due to the work of "Apple Red Bugs," and, later in the season when specimens of the insects as well as their work were collected by Messrs. Stafford and Dickerson at the College Farm, at High Bridge, at Bridgeton and in other sections of the State, it was possible to identify with certainty the "false" red bug, as the true species at fault in our State.

In New York there are apparently two species at fault; similar in size and color, very much alike in general life history and yet sufficiently unlike in all stages and in development to be easily distinguishable at all times. Thus far only the somewhat smaller, rather more slender and less punctured form has been found in New Jersey, and that is the one to which the term "false" red bug has been applied, although it is as uniformly bright tomato red as the other species.

The winter is passed on the trees in the egg stage concealed in the bark tissue, and the young or nymphs are hatched in the early spring very soon after the trees make a start. The young, as in all true bugs, puncture the leaf tissue and cause distortion as well as discoloration; the distortion often taking the form of twisting or curling which serves as a concealment to the insect.

Like most of the true plant bugs these "red bugs" are active, light on their feet, very elusive and difficult to capture. Even when there are a number of specimens present and even when they are not winged they are nevertheless difficult to capture and are not even readily seen by one who does not know pretty nearly what to look for.

The injury caused on the foliage seems to be rather a minor matter thus far in our State; but the injury to the fruit is more serious. The young apple also is punctured for food, and wherever a feeding puncture is made a check in growth results. The outcome is, on some varieties at least, a collection of curious freaks of little or no commercial value, a drain on the trees, even if not a direct menace to them.

Nowhere have we found the insect harmful enough as yet to require practical treatment; but it seems to have become important enough in New York, and the New Jersey grower should be on the lookout ready to deal with the insect at the beginning. It requires about five weeks to come to maturity and spends most of the season in the bark tissue in the egg stage; but during the five weeks of early season it is capable of considerable injury that will hang through the balance of the season.

As to remedial measures it is hardly worth while going into details as yet before we know definitely whether one or both species will have to be dealt with. It will, apparently, require the addition of a tobacco extract to our spring battery, and that would mean a material advance in cost.

Pear Midge.

After so bizarre and abnormal an appearance as this insect made at New Brunswick last year some sort of abnormity might not unreasonably have been expected during the season of 1911. But on the contrary the insect was almost completely absent. I never had so full a crop of Vermont Beauty Pears which came to entire perfection and with scarcely a trace of the insect at any part of the season. At the College Farm Mr. Blake reported a few specimens of Seckle infested and that was all. The insect just barely maintains itself in an aggravating way that makes it impossible to adopt any systematic measures against it; because one never knows where the next attack is to be repulsed nor what

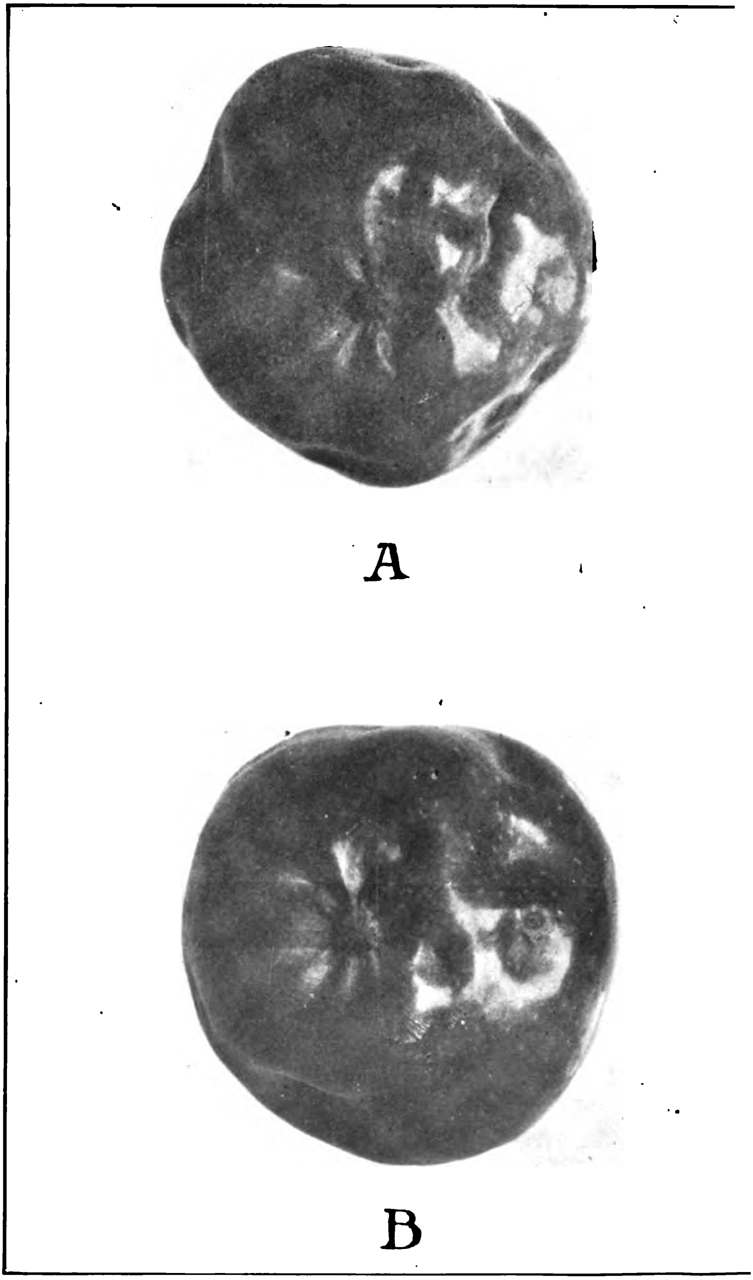

Figure 4.
Injury to apple fruit from the false red bug.

nature is going to do. An attitude of expectation is therefore the only possible one, with such measures of relief as are permitted each year by the nature of the infestation.

Pear Psylla.

It is rare nowadays that reports of injury from this insect are received, because almost every pear grower knows it and knows how to deal with it as soon as it makes its appearance in his orchard. It is only when it seems to make its appearance in a new locality or to attack a new variety that it attracts attention, and that samples are sent in in order to make certain of the nature of the attack.

Thus, for the first time in many years, specimens of the insects were received during the summer from Atlantic county with the report that they were attacking the Koonze pear. This was rather a new habit for the insect, and the grower wished to make certain that he had only an old friend or enemy to deal with before taking the necessary steps in the matter. It seems that there is almost no variety that is entirely exempt from the attacks of this insect, and that we have got to keep a lookout for it on practically every variety that is grown.

The Maple Pseudococcus or False Scale.

This insect has attracted attention throughout the State and has been perhaps the one most generally reported on shade trees outside of the elm leaf beetle. Both the leaf form and the trunk form have been complained of, and on the whole the leaf form has been found more abundant and has been more frequently referred to than the trunk form.

When the insect made its first appearance in the State a few years ago, the trunks of the trees became so covered that they appeared to be whitewashed, and in some instances thick accumulations of cottony material were found on the surface. This form of infestation seems to be less abundant at the present time; but there seems to be more complaint of infestation on the underside of the leaf and the consequent dropping of the leaves in the early part of the season after a premature ripening.

This is one of those insects that is best dealt with in winter so far as the trunk form is concerned, and so far as the leaf form is concerned is best dealt with as the leaves drop. The infested leaves tend to become lifeless, especially during a droughty spell in middle or late summer and then drop to the ground. If they are kept raked up and burnt, the insects will be, of course, destroyed, and there will be nothing to go through the winter. The recommendation has been made that in cities and towns the trunk form can be kept in check by the use of the solid jet on the trunks, using the ordinary water pressure, and this recommendation is a good one. During the winter these insects are particularly exposed to the effects of the miscible oils, because they hibernate in the crevices of the bark and in the lower parts of the tree trunks. Even strong solutions can be used there without danger to the tree and with good effect against the insects. In fact, for ordinary city trees this particular species ought not to offer any serious difficulties whatever.

Oyster-Shell Bark-Louse.

Lepidosaphis ulmi Schimer.

It is actually a fact that this common native species is again replacing the San José or pernicious scale as the form most frequently received by the Entomologist with request for information. It is not, as a matter of fact, more abundant than it ever was; but the relative disappearance of the pernicious scale from the garden and shade tree field has restored this form to so much of its old time importance that it attracts more attention.

It is really the most common of the species sent in at the present time and the one demanding the greatest amount of information from correspondents. In a way it is really not so easily dealt with as the San José Scale because that could be dealt with at practically all times during the winter.

The oyster bark scale cannot be dealt with during the winter, but does give an excellent opportunity to look over many a nasty jungle during late winter and clean and trim out a mess that ought never to be allowed to go along into June.

In any reasonably well-kept orchard the oyster-shell bark-louse will keep itself in fair condition without especial attention. In similar plants will run itself to a stage when it threatens the plants it primarily infests and its surroundings. It is always a threat to maple and elm and has a large range of food plants to which it may be dangerous than any other except the pernicious scale.

A wide range of excursions by allied species into greenhouse plants has been investigated by Mr. Weiss, but forms a distinct feature of study.

The San José Scale.

There are a great many persons in the State of New Jersey who believe that this insect is a back number and one that needs little or no more attention. There are a few persons who did have that belief, who know emphatically that it is a living issue, and that it is a species that needs the most careful attention. There are others who know that both of these statements are locally and approximately true, and that he who runs carefully and works cautiously will come nearest to being right.

In the course of our nursery inspections we hit every part of the State, every variety of growth, and every condition under which plants are grown and almost everywhere orchard stock in connection with the nursery stock. The judgment formed in this work therefore may be considered in general well based for the State, and we do not by any means consider the scale a negligible factor. That it is no longer the virulent pest of ten or a dozen years ago is true in most cases, but I would not trust the species anywhere where it seemed to have a good hold and a healthy start. So also as it seemed late in starting in the hills of North Jersey among the apple trees, it seems first to lose its hold there.

Apple buyers who have been over the crop carefully with the object of storing for winter, report orchards free from infestation that were not worth buying three or four years ago, and without treatment of any kind.

On the other hand, growers who found so little scale in their orchard this spring that they concluded to risk without application of insecticides, find their crops at harvest so badly infested as to be almost unsalable.

My advice in all cases is to watch the insects closely. With the miscible oils and the commercial lime and sulphur mixtures we have so strong a hold on the species that we can check it with much greater certainty than ever before, and it has lost its old terrors which seemed to be based on the idea that we were practically helpless as against it.

The worst section of the State is perhaps the Delaware river section of Burlington county, and the scale is perhaps more flourishing there than almost anywhere else.

In our nurseries it has been almost completely eradicated, so that most growers prefer to destroy the few infested plants rather than treat them. No honest man has an excuse nowadays for selling an infested plant, and no one is in the position to do so ignorantly.

As for remedial measures nothing has been added to our batteries. Scalecide and other miscible oils are still recommended and used, except where the lime and sulphur combinations have especially approved themselves.

A New Clover Weevil.

Mr. E. G. Titus, who has been studying the species of the genus *Phytonomus,* which includes the common clover leaf beetle and also the newly introduced alfalfa weevil, reports that among the material received by him from New Jersey there occurred specimens of the European species *Phytonomus melus* Fabr.

This pest feeds on red clover and was bred on that plant at Albany, New York, by the State Entomologist, Dr. E. P. Felt. In New Jersey it has been found at Ramsey, Hewitt, Lake Hopatcong, Newfoundland and Rahway, from late May to the end of July. Specimens are reported also from Connecticut and Massachusetts, and it is certain that the species has been with us for a number of years and has become widely distributed. Whether it will graduate into a serious pest is yet a question.

Mr. E. A. Bischoff, of Newark, has found it in some numbers at Springfield, during the present season, so that a continued increase may be expected.

Shade Tree Insects.

There were not so many inquiries concerning these insects as usual when the gamut of species is considered as a whole; indeed the shade tree commissions as a whole did a great deal of their work outside of that with elms and maples by digging out the facts themselves and thus getting first hand information except in the case of borers. These proved troublesome all over the State, and on quite a large range of trees. Less indeed in the case of the large species like the wood-leopard moth which might have been supposed to give most difficulty than in the case of the maple and hickory species which appeared in more isolated numbers and in more scattered localities throughout the State.

It is an interesting and encouraging feature that tree owners are exercising a great deal more interest in this kind of property and are actually realizing that attention to it pays.

The organization under the auspices of the State Forester of a State organization and the appointment of a State Plant Pathologist, cannot but help forward and favor the case of and an interest in shade trees.

The Poplar Leaf Beetle.

Melasoma scripta Fab.

Throughout the State on young trees of willow, poplar, and to a less extent on elm, and particularly in nurseries, the larvæ of this beetle have been unusually abundant and injurious. In some nurseries the insects were so abundant that it was necessary to spray in order to prevent complete defoliation, and in some places, where poplars were recently set out, the young trees were completely defoliated and seriously injured. Willows were much less injured and older trees were in general attacked while elms received incidental attention only. This is a species that is always more or less abundant in some sections of the State on young nursery trees; but which rarely makes its way beyond nursery confines. Weather conditions in the early part of the season seemed particularly favorable, however, and the beetles found it possible to pupate and produce maximum broods. It was only prior to mid-summer, however, that the insects were abundant or troublesome, and later on their parasites and other natural enemies brought them down to their normal harmless condition.

The Mourning Cloak Butterfly.

Vanessa antiopa Linn.

It is not often that a true butterfly becomes injurious in this State; but this common Mourning Cloak Butterfly certainly was abundant enough to attract attention during the early days of the season on elm trees, and it was not so much that it was injurious in itself and attracted attention by its spiny character and appearance, but it was quite generally mistaken for the caterpillar of the Gypsy Moth, and it was sent in on several occasions for that insect from different parts of the State. I found it myself at New Brunswick in localities where, under ordinary circumstances, the caterpillar is rare. It was brought in by correspondents to the office, and sent in from almost every portion of the State, so that the conditions that favored its increase were not local but statewide. There had been no unusual hibernation of adults, because I would have noticed that, or it would have been brought to my attention, and there seemed to be no unusual increase in the size of the butterfly brood that made its appearance in mid-summer. There was simply a large increase in the first brood of caterpillars, which was abnormal, which attracted attention and which disappeared without leaving a trace later on. It was only on elms that the insects made their appearance, and none of the other normal food plants seemed to be unduly attacked.

The Cotton Moth.

Alabama argilacea Hbn.

A curious and interesting occurrence in late September and early October were the flights of swarms of the Cotton Moth which came into New Jersey and adjoining States, and were observed at the lights of various cities and towns in greater or less numbers. I found an example of the moths, in perfect condition, were sent in from the most northern towns, they were reported in enormous quantities at Atlantic City, and examples came in to me, for determination, from Connecticut.

Of course, these insects created uneasiness for which there was no justification, for their presence was purely as adult migrants incapable of feeding or other injury. But it did indicate a condition in the Southern or Cotton States that favored the development of a terrific brood, and the consequent serious injury to the foliage of the plants whether generally or of one particular district only.

The European Hornet.

A few years ago occasional specimens of the European hornet (*Vespa crabro*) were found in the vicinity of New York City and in New Jersey, and some good nests were found by New York Entomologists and figured. Since that time the insects have spread in New Jersey and are beginning to be a nuisance.

They are much larger than our own white-faced wasp or hornet and much more aggressive. They build their nests usually in concealment in hollow trees, or in attics or in shelters of that general character. Small colonies will get into bird houses or other similar places and will fill them with their paper nests. While the nests are somewhat similar in character to those made by our common paper wasp, they are not nearly so tough and do not stand the weather as well. They are more brittle, more rotten and go to pieces much more easily.

The workers have a fashion of girdling the plants from which they gather their wood fiber, and lilacs are among the favored plants from which fibre is gathered. Furthermore, the hornets are great fruit eaters, and will chew into apples, pears and other fruits, particularly when they are just a trifle over-ripened. They become most offensive in September, and have now extended almost throughout the State, specimens having been sent in from the heart of the pines in South Jersey, as well as from almost the northernmost county of the State.

Routine Work.

The usual routine work of the department has been continued in the way of attendance on meetings of various kinds, scientific and formal, and addresses have been prepared and delivered before various agricultural and scientific bodies. Not the least influence now wielded by the office comes in this way, and it requires an ever increasing amount of time and labor to look after these matters. Institute and other formal meetings have come to assume a very great importance in our agricultural life, and when the meetings of the larger state bodies are added they become of dominant influence.

The scientific bodies at Newark, New York, Brooklyn, Trenton and Philadelphia have continued to receive my attention as well as the national bodies meeting at Washington and elsewhere throughout the State and the United States.

Miss A. E. Meske is still in charge of the routine and clerical work of the service, and, aside from circular work of the State Entomologist, something like 4,000 separate communications have been sent out. The bee inspection work has added very materially to her labors without adding anything to her pay.

Elm Leaf Beetle.

As stated in the report for 1910, the beetle brood for that season matured normally and entered the hibernating state in good condition. The prediction that was made concerning the probable numbers and extent of injury for 1911 was also fulfilled to the letter. Nothing occurred during the winter to lessen the number of beetles, and the adults came out in full force in early spring, although, owing to cool weather, a little more gradually than usual.

The first beetles were seen on the windows about the usual date in April, and the probabilities began to become more definite in early May, when large numbers of beetles were sent in by housekeepers who failed to recognize them and feared for their woolens and other supplies.

Shade tree commissions were early in the field, and those newly organized became active in good season; a few purchasing spraying outfits of their own, while most of them arranged to have the work done by one of the commercial companies.

emergence from hibernation produced a long period of oviposition or egg-laying, and the earliest larvæ or slugs hatched before egg-laying became general. This made it difficult to time the spraying where one application only was to be depended on. It was my purpose to try this scheme on the College elms, and work was begun on May 16th and finished next day. The material was the Electro Arsenate of Lead, dry, 15 pounds in a 200 gallon tank.

A couple of slight but dashing showers, the rapid development of new foliage and the additions to the egg masses made me doubt the wisdom of relying on a single application; the more, as some of the work, done by a temporary assistant, was doubtful as to its thoroughness. A second spraying was made, therefore, beginning June 5th and taking part of three days. The material was identical, but only 10 pounds of the lead was used in the 200 gallons of water.

The result was all that could be desired. The trees never looked better in all their history, and they stood out in more or less sharp contrast to all the other trees in the city, sprayed or unsprayed.

The City Improvement Society arranged for the treatment of many of the elms by a commercial company, and one very imperfect application was made. So imperfect that some of the sprayed trees were in no way better than those not treated.

In my journeys through the State I kept a general outlook for conditions, and throughout, the cities and towns that made any effort at all to save their trees, were in better condition than the others.

As the season advanced the low temperature and drought told ever more badly on the city trees, and the work of the beetles and their larvæ became ever more apparent, until the time when the larvæ were full grown and about ready for pupation. Then ensued a period of intense heat and great humidity, and with this came the development of that disease trouble that swept out of existence millions of larvæ and pupæ and left for development into adults so small a percentage that their feeding was scarcely noticeable. When this condition of affairs was recognized in New Brunswick, I instructed all assistants to note conditions everywhere and to report concerning the manner in which adults of the summer brood were developing; and in a general way their observations agreed with my own.

To make matters yet more definite, however, I had a systematic examination made in several cities and towns, in some of which work had been done, in others of which nothing had been done, and part of the reports of conditions in late July and early August should prove interesting:

Rahway—

Elm trees examined		234
Good to fair 18 per cent. or	42	
Dead and dying	52	
Probably beyond hope	100	
Savable	40	
		234

Elizabeth—

Elm trees examined		625
Good to fair 35 per cent. or	222	
Dead and dying	95	
Probably beyond hope	219	
Savable	89	
		625

Bound Brook—

Elm trees examined		71
Good to fair 24 per cent. or	17	
Probably beyond hope	43	
Savable	11	
		71

Somerville—

Elm trees examined		307
Good to fair 16 per cent. or	50	
Probably beyond hope	210	
Savable	47	
		307

Plainfield—

Elm trees examined		739
Good to fair 47 per cent. or	347	
Dead and dying	12	
Probably beyond hope	218	
Savable	162	
		739

Rahway has done practically nothing for her trees, and many elms have already been taken out.

Elizabeth looked after her trees for some years, but recently has neglected them.

Bound Brook has not done any systematic work that I know of.

Somerville is in the same case, and her plight is a bad one, because much of the beauty of some of the streets and open spaces is dependent upon the elms, some of which are very large and fine.

Plainfield has treated the greater part of its trees more or less systematically, and the percentage of good trees is large. But the number of very seriously injured trees is altogether too large for a city of its character, and another season of neglect with an injurious infestation will turn a fairly good showing into a contrary one.

A somewhat less detailed statement was prepared for Summit, Chatham, Madison, Convent and Morristown, at all of which points the trees have been systematically looked after by regular shade tree commissions or some effective body.

Summit—80 per cent. of the elms are in fine condition.
Chatham—45 per cent. of the elms are in good condition.
Madison—70 per cent. of the elms are in good condition.
Convent—Only a few elms, all in good condition.
Morristown—90 per cent. of the elms in fine condition.

The really important result of the inspection was not so much to bring out the condition of the trees at these various points, as to bring out the fact that the same conditions that operated at New Brunswick to lessen the number of maturing beetles, operated also at all these places whether trees were sprayed or not, and the smallest brood of adults for years past is now in hibernation.

This does not mean that everywhere there are only a few beetles in winter quarters—it means that the percentage of specimens that matured is very small, and that where trees were kept in good condition and larvæ were few in 1911, there will be very few beetles to start the season in 1912. It will offer also an excellent chance in 1912 for those municipalities whose trees are not already beyond hope, to get them into tolerably good condition to resist the attack for that year.

Peach Borer.

Sanninoidea exitiosa Say.

Rather extensive observations were made and reported on in 1910, and Bulletin No. 235 gives in compact form the conclusions that seem warranted from the observations made in this State.

During the season of 1911 a little additional work was done, and the insects were kept under a general sort of observation.

In the nurseries Mr. Dickerson noted the presence of the insect rather more particularly and closely than usual, and broke down a considerable number of badly infested trees. The attention of tree growers was called also to the presence of the insect and a good many infested trees were undoubtedly thrown out by dealers. We did not, however, in any case make the presence of this insect in a nursery an excuse for refusing a certificate.

Mr. Dickerson also made two visits to the Mercerville orchard where some of our work was done in 1910, and there is no doubt that the work done there in the last year had a very good general effect.

June 16th, borers of small and moderate size were found in small numbers among others about full-grown and ready to spin up. Only two full grown pupæ were found.

July 6th, another search was made, chiefly for pupæ this time, and two empty pupal cases of this year's formation were discovered. In other words, adults had already begun to issue. The number of larvæ had been much reduced as compared with last year, and it was chiefly along the outer rows that specimens were found in any numbers. Only cocoons were brought in, and from these adults began to emerge, July 12th, and continued until the 24th of that month, when the supply was apparently exhausted.

Incidental examinations were made in orchards by Mr. Weiss and myself and more systematic work was done at Vineland and at High Bridge by Mr. Stafford. The first regular worming at Vineland was done June 12th, by Mr. Thrasher, one of the assistants in the horticultural department, and the results of the work were turned over to us. Quite a range of size was represented and there was one pupa.

June 16th, Mr. Stafford found them quite abundant in the experiment orchard—3 or 4 per tree and approaching full size. In the Voorhees orchard adjacent they were even more abundant, and some 200 well grown specimens were brought back to New Brunswick.

June 26th, at Vineland, in an orchard adjoining the experiment ground, found the larvæ abundant and well grown, and in some cases accompanied by a *Mycetoplylid* in considerable numbers.

Meanwhile I had been over the Gypsy Moth area in Massachusetts again and had noted the improvements made in tanglefoot, and the extent to which it was depended upon to keep the trees free from caterpillars. I noted also, and this was confirmed by Mr. Rogers and others, that as now prepared, no penetration or injury accompanied its use, and that even the thin-barked trees could be safely banded, even when the material was put on an absolutely smooth surface.

I therefore arranged with Mr. Rogers for a pail of this thin tanglefoot for experimental work, and on June 30th, Mr. Stafford treated the trunks of 21 peach trees in row 25 of the experiment orchard. It was applied from the surface to about 18 inches above, and about 1/8 inch thick, forming, of course, a uniform sticky coat.

Borowax is a new protective material put on the market by the J. T. Lovett Co., of Little Silver, to prevent borers from injuring peach trees, and a quantity of that having been sent in for trial just in time for use here, was applied to 24 trees on row 26. It was put on quickly and easily with a brush, a little thicker than in rough painting, and it dried rapidly. On the east side of Dr. Voorhees' orchard, where the borer infestation had been worst, treated a row of about 40 trees—the fourth from the east edge.

July 10th, at Vineland, treated 20 trees with tanglefoot from the surface to a distance one foot above ground. These were trees right in the midde of a badly infested orchard which had not been wormed, and the plan was to capture the adults on the sticky surface as they emerged or before they had an opportunity to mate or oviposit.

July 14th, High Bridge, examined the tanglefoot and borowax put on June 30th. Borowax is perfectly dry, gives off practically no odor, has not in any way affected the epidermis beneath it and can be scraped off the surface as a waxy sticky powder. It forms over the surface of the bark a thin, hard, dry enamel, and that is all.

The tanglefoot was just about as when put on, except that on the surface greenish-yellow leaf-hoppers were very plentiful; moths of various kinds, a few; grasshopper nymphs, a few; adult Periodical cicada, one; Coccinellid beetles, a very few. Also a number of yellowed leaves. No *Sanninoidea* in any case.

Applied tanglefoot to 15 wholly untreated trees in the Voorhees orchard to determine the possibility of capturing moths with it.

July 24th, looked over the tanglefoot trees and found stuck in the material, Coccinellids, Elaters, Bostrychids and Tenebrionids. A variety of Hemiptera and Jassids. Mosquitoes, Muscids and a variety of smaller flies. Various small moths. Chalcids and a variety of Hymenoptera.

While looking over these trees I saw a Capsid bug walk down, over the tanglefoot from about 6–8 inches above, to the surface and off to safety. I found a *S. exitiosa,* female, resting on the tanglefoot on one of the trees, head upward and about 3 inches from the ground surface. I was strongly under the impression that she was hopelessly stuck; but when I touched her with a pencil point to make sure of this, she took wing and flew without the slightest difficulty.

Tanglefoot seemed to have collected an infinitesimal film of dust over its surface such as would permit a delicate, light footed insect to walk over it.

August 1st, at High Bridge, there had been no change in the borowax trees, while the collections on the tanglefoot had increased without including any *Sanninoidea.*

August 10th, at Vineland, the tanglefoot, owing to hot weather was in prime condition as to adhesiveness and softness, and a very large number of insects were adherent to it; but no *Sanninoidea.* In view of the conditions that favored penetration I cut slivers from a number of coated trees and found no evidences of penetration. It appeared to have remained strictly on the outside in all cases.

The tanglefoot and borowax trees were, later on compared as to appearance with untreated rows adjacent and no differences were noted. Neither of the materials had the least injurious effect on the trees.

On the other hand, in some cases borer castings and exudations appeared in the treated area itself, so it is a question whether any good was done by the coating. But as some of the coatings were applied *after* the first moths had appeared, it is at least possible that the very young larva was already at work when the "preventive" was done.

Conditions at High Bridge were noted September 22d. The tanglefoot was as sticky as when first applied and formed the same complete and uniform coating. In none of the trees did I find any trace of borer workings nor were any adults stuck on the treated area which was covered with a great variety of species in various orders.

The borowax on the larger trees of the experiment orchard is in much the same condition as when first put on. In a very few places, however, it had split with the growth of the tree. These trees are from 4 inches to 5 inches in diameter. In the Voorhees orchard, where the trees are 2–2½ inches in diameter, a large amount of splitting of the borowax coating occurred. In half a dozen cases, in such splits I found evidence of borers but not th borers themselves.

However, that was also the experience on untreated trees wh similar evidence of borer attack was noticed without being abl locate the insect itself.

Neither tanglefoot nor borowax had in any way impaire general health of the tree as compared with the untreated mens, and both materials seem to remain strictly on the sur

Judging from the record the tanglefoot is worthy of more systematic test, while the borowax does not offer ducement in that direction.

A persistent effort has been made by a white lead c secure the trial of one of its products, guaranteed as thinned down with a pure linseed oil, as a repellant o and some old experiences of my own indicate that if are favorable the material may work well. But i or turpentine is used in the paint it will mean eit seriously injured tree.

For the present I am not ready to add anythi mendations made for treatment, in Bulletin No.

Cranberry Insects.

Weather conditions were extremely favo ment of cranberry insects and of injury to sult there was more complaint from growe for years past. The older, more exper recognized the attacks under the new p less experience, accustomed to the usu routine, supposed there was some new p structive meeting and discussion on t Mount Holly meeting in August.

The winter of 1910–'11 was not very severe, contained no extremes of cold, nor on the other hand, any serious warm spells. It was simply a rather mild even sort of winter which was favorable for almost all sorts of insect life.

Vine-Worms.

Both the yellow-heads and black-heads were unusually abundant except where proper reflowing was practiced, and both for climatic reasons. Compared with 1910 the season was about two weeks late in starting, and spring temperatures on the whole were low. The results were that the eggs of the black-head on the water covered leaves of the vines remained fully dormant even where the water was shallow, until the water was actually drawn off, while the adults of the yellow-head were kept in winter quarters by cold nights until the normal period for uncovering bogs was at hand.

The result was an unusually heavy early brood of both yellow-heads and black-heads which, nevertheless, was not generally noticed by growers until it was nearly full grown, but which became conspicuous by a numerous and husky second brood.

Cranberries bloom and set chiefly during the early half of July, and that is exactly the time these vine-worms were present in greatest numbers, the black-head being the chief culprit in most cases. Large areas were cleaned up altogether even where spraying had been done and, where berries had already set, many were eaten out by the worms. And they have left their threat behind, for, in early August, on an Atlantic county bog I found eggs present in great quantity. On one runner I found every upright with at least one egg, and on some uprights there were from two to four leaflets with eggs present.

I have nothing to add to the remedial measures; nothing equals reflowing done at the proper time to kill off the first brood. Thorough spraying with Paris green or arsenate of lead will undoubtedly kill off a very large percentage of the larvæ; but their feeding habits are such that unless the applications are remarkably well-timed a great deal of injury will be done.

Cut-Worms.

There is nothing at present recognized on New Jersey bogs such as a specific Cranberry Cut-worm. There are plenty of cut-worms that feed on cranberries and some, like the army-worm often do serious damage on the bogs. Other, more typical species are reported each year, but scarcely twice alike from different localities, so that it is usually a local condition due to some species that becomes temporarily abundant.

One of the tricks of cut-worms is to climb to the tips of the plants, cut off the juicy terminal shoots or blossoms and thus cause injury out of all proportion to the actual amount of vegetable matter eaten. This habit forms the basis of much of the complaint of blossom worm for the current year and is, no doubt, responsible for a very large percentage of the fruit loss not directly traceable to the work of the vine-worms.

Wherever cut-worms are known to occur on cranberry bogs, the early sprayings of bordeaux mixture should have an addition of one pound of Paris green for every 100 gallons of the fungicide.

Where reflowing is practiced, cut-worms will never prove seriously injurious.

Girdle-Worms.

More complaints of this pest have come in during the present summer than ever before in my experience, and I have no satisfactory explanation for this fact. It is possible that a change in practice and a greater freedom of our bogs from grass has made a change, for the insect is a grass-feeder primarily.

As to remedial measures, the best and most effective is undoubtedly a temporary flowing just after picking is completed. The larvæ are then still in open tubes and will not survive submergence more than four or five days. In case of serious infestation I would advise a week, however, and this will not injure the plants at that season.

Burning off the infested area with a gasoline torch has been tried with more or less success, and if that is done, the burning must be complete to the bare ground itself, and must be carried well beyond the dead area so as to be sure to get all the infestation. New plants can be set out at once on such a burnt over area and the bare place covered rapidly.

It may be well to call attention, however, to the fact that not all eating along the vines at the surface of the ground is due to girdle-worm. Almost any of the ground beetles or grubs may do this from time to time, and even cut-worms score the bark occasionally. Crickets have been found gnawing the bark of the vines, and even white grubs are occasionally found in dry bogs.

The true girdle-worm is a green caterpillar that lives in a silken tube at or near the surface of the ground, and gets to be about an inch in length before it is full grown. The tube is covered with dirt like the surface soil, and is rarely recognized by the grower hunting for the caterpillar as the covering of the insect sought by him.

Tip Worm.

This has undoubtedly caused injury on some bogs; but usually where the growth was weak and the vines not thrifty. Uprights, runners and fruiting shoots are all attacked and the growth is stopped or stunted. It does not hurt the crop of a fruit bearing upright on the year it is attacked; but if the attack comes in August on uprights or fruit spurs, no buds form for fruits the year thereafter, if the vines are at all feeble or unthrifty. I have seen many bogs badly tipped yet with good crops and good fruit sets. But I have also seen—more of late years—where the set of fruit buds had been materially checked by this insect.

This species appears to be altogether beyond reach of insecticides. There is a more or less irregular breeding throughout the season, more abundant in early summer and less on reflowed bogs. In some localities it is almost unknown; in others it occurs only along the edges and higher portions of the bogs, and in most places it is least abundant on the deepest areas of the cranberry meadow.

Cranberry Practice.

Since I first began work on the bogs, in 1884, a vast change has taken place in practice. At that time little was definitely known of any of the insects, nothing at all of some of them, and our knowledge of diseases was a complete blank. First, as field agent for the United States Department of Agriculture, I spent two seasons on Cape Cod and in New Jersey. Then as entomologist for the Experiment Station in this State I have gradually filled gaps in our knowledge until, at the present time, most of our pests are pretty well recognized and the method of dealing with them is pretty well known to most growers.

When I first began work with insecticides our battery of poisons was limited, and our means of application exceedingly crude. Field and orchard spraying was in its infancy and the possibility of covering a bog was not even seriously considered. But as machinery improved and poisons were shown to be effective, some growers who had an insufficient supply of water turned to spray pumps as an alternative to losing their crops altogether, and a sufficient measure of success was obtained to keep alive and increase the practice.

As our knowledge of the cranberry diseases entered into a new stage, and when it was demonstrated that some of these could be controlled by spraying, there was yet another factor, and now there are no more elaborate outfits for the applications of fungicides and insecticides in New Jersey, than there are on our cranberry bogs.

And nowadays a sprayed cranberry bog looks quite different from the bog of olden days. Then grasshoppers—long and short-horned, and katydids hopped and flew up before you. Leaf hoppers swarmed, and so did hosts of beetles and other insects. There was good collecting for the entomologist at almost any time, and a source of supply for a great variety of species whenever he wanted them.

In the early part of August, 1911, I visited, with Mr. Rider, the secretary of the Cranberry Growers' Association, an Atlantic county sprayed bog. Not a katydid was seen; not a grasshopper except along the dams, and scarcely a leaf hopper. There were no grass moths, no beetles, and for the entomologist there was a distressing lack of interest, except where the vine-worms had gotten in their work.

May Beetles.

In number of specimens and species and in amount of injury, the season of 1911 was unique so far as "May-beetles" or "June-bugs" are concerned. As soon as the first warm days of April came on the vanguard of the specimens made their appearance, although it was not until well along in May that they became really abundant. No less than seven distinct species made their appearance in considerable numbers at New Brunswick, and others appeared in the vicinity in smaller numbers. Some of the species commonly represented this year are not usually abundant here, and all the usual species occurred in large numbers.

This was not a unique feature at New Brunswick, nor even in New Jersey, but seems to have been within the experience of a number of collectors in adjacent States. Up to the early days of June the insects continued in large numbers and then gradually declined until, during the last days of the month, only single specimens were obtainable.

The species in the order of their abundance at New Brunswick were: *Lachnosterna arcuata, L. dubia, L. hirticula, L. ilicis, L. fraterna, L. tristis,* and *L. fusca.* The species occurring after June 20th were not listed.

As to the injury caused that was not generally recognized. On a variety of shade trees they chewed the leaf stems and petioles and caused a dropping, the reason for which was not usually understood. On fruit trees blossoms were eaten and later the recently set fruit was scarred and disfigured to a greater or less extent. Peaches were not generally touched, but most of the smooth fruits except cherries suffered to a greater or less extent.

The actual injury caused by the adults is small, however, compared to the danger from the large crop of white grubs derived from this unusual abundance.

Rose Chafer.

This insect has been quite as abundant as usual throughout the southern part of the State, and has done just about the usual amount of injury. As is always the case, there were some localities where it was not quite as bad as it was during the few years last past, and corresponding localities where it was worse. In each instance the determining factor has been the opportunity that the larvæ have had for breeding, and the large vineyard areas in South Jersey that have been practically exempt from injury from this insect during the past summer have been so chiefly, because the methods of cultivation have practically done away with the opportunities for larval breeding.

The larvæ of this insect is a white grub. It lives under ground and lives on the roots of grasses and weeds. Wherever there are weedy orchards or vineyards, or neglected grass lands, there the beetles will breed. There also injury will be most severe during the season following.

As usual a great number of experiments were made with insecticides of all kinds to prevent injury, and either to repel the insects or to kill them off promptly. For the first time there seems to have been some agreement in results during the present season. It seems to be the uniform experience that the addition of glucose to a mixture of arsenate of lead either increased the attractiveness of the poison to the beetle or its effect, and at all events, that arsenate of lead at the rate of one pound in ten gallons of water, adding a quart of glucose to the mixture, would kill where the arsenate of lead without the glucose had no such result. I did find a man who claimed that he had satisfactory results even without the glucose, using the arsenate of lead alone; but his was a single case, while others who reported good results reported not only from New Jersey, but from a number of other States extending almost to the middle west. It seems likely then that the addition of glucose to an arsenate of lead mixture will give us control over this miserable beetle that heretofore has defied our most powerful poisons. Just what there is in the glucose that should enhance the effectiveness of the arsenate of lead so materially no one seems to know definitely up to the present time. We may for the present, however, accept it as a fact and use the mixture empirically until we manage to work out the explanation.

Other Leaf Chafers.

Quite a number of other leaf-chafers were sent in from time to time during the season, or were taken on orchard or other fruits. Among these, one of the smaller and more unusual, was the iridescent silky little species known as *Serica iricolor* which occurred during May on peach trees in the more southern parts of the State.

It is one of those species that has a very brief period of flight, and it was possible to advise those that sent in specimens that by the time information could get to them concerning methods of control, the need for them would be over; and so it was in every instance, no appreciable injury having been caused in any case.

Larva of Fig Eaters.

Several times there were received from South Jersey after midsummer the hairy white grubs of the fig eaters, or larvæ of *Allorhina nitida,* with the story that they were undermining lawns and grass plots generally and causing a great deal of injury. These insects are always more or less injurious in South Jersey after mid-summer, and the brilliant velvety green and bronze beetles are not infrequently seen flying about over the surface of the lawns. They occasionally get into such fruits as are ripe at that time; but as a rule attract attention only of the children who know them as "June bugs."

They are not harmful to cultivated crops, and on lawns it is frequently best to turn up the entire carpet of turf, destroy the grubs mechanically or with a strong kerosene emulsion and simply reseed or resod. Where the injury is less marked, kerosene emulsion washed through the turf will very frequently destroy the larvæ and save the grass.

The Spinach, or Beet-Leaf Maggot.*

Pegomyia vicina Lint.

This insect, in its larval stage, is known as the spinach, or beet-leaf maggot or miner, as in that stage it mines in the leaves of these plants. It was first reported by Dr. J. A. Litner, entomologist of New York State, in 1882, when he reared this and two other species of *Diptera* from beets and described it. Since then observers from the Atlantic to the Pacific have reported it as similarly injuring these plants.

In the New Jersey report for 1909, the species was noted as occurring at Richfield, Passaic county, infesting beet leaves to such an extent that it was impossible to bunch the beets.

***Prepared chiefly by Mr. E. L. Dickerson, from his own observations and from office notes and published data.**

Early in 1911 a report came from Little Silver, Monmouth county, that the insect had been troublesome in spinach in 1910, and was again beginning to make its appearance. Accordingly, on May 5th, Mr. H. B. Weiss visited the farm of Mr. H. M. Sickles, whence the insects had been reported as injurious. The spinach had made a good start, the leaves had become from half an inch to an inch and a half long, and on the under surface of a number of them the white eggs of this species in clusters and singly were noted. A few had hatched and larvæ were seen in the leaves, the injury being about one-eighth inch in diameter. Evidently oviposition had been in progress for several days.

May 17th, I visited the place to note progress. In the spinach bed where Mr. Weiss had found the insects on May 5th, part of the plants had been cut; but on the remaining ones more eggs were noted than occurred at the time of his visit. Many leaves bore several groups of eggs and some showed rather large mined portions. As some of these contained no larvæ it appeared as if a few maggots had matured. In some cases maggots may have migrated to fresh leaves, but I saw no evidence of this.

Growing along the rows of spinach were numerous young plants of Lamb's-quarters or Pigweed, *Chenopodium album,* L., and scarcely a plant of this could be found which did not bear on its leaves a larger or smaller number of these same eggs. It appeared, here, that the flies had preferred this weed to the spinach as a place for oviposition. While part of the eggs had hatched, many were still unhatched, and as flies were also to be found, it appeared that egg-laying was still in progress. Next to the spinach was a bed of beets, and while the leaves of these plants were sufficiently developed to serve for oviposition it is interesting to note that only a small number of eggs could be found upon them. Some distance from this spot another and younger bed of spinach was situated, and this showed less infestation than the one above noted.

May 26th, the place was again visited. The rest of the spinach in the older bed had been cut, but there was much breeding in the leaves of the Lamb's-quarters, in and about the spinach bed, and in the beets a much greater infestation was noted than on May 17th.

Breeding was also noted in the younger spinach bed and in other plants of Lamb's-quarters about the place. The flies did not appear to be as numerous as a week earlier, and while a number of unhatched eggs could be found, it appeared that most of the oviposition of this first brood had taken place.

Another visit was made to the Sickle's farm, August 1st, but no flies were noted about the place, and scarcely any eggs or larvæ could be found on or in the plants.

Not only was this species observed at Little Silver, but, as opportunity served, wherever Lamb's-quarters was found, it was examined to ascertain whether or not the fly was present, and in almost every instance some infested plants would be found.

May 18th, at Trenton and also at Newark, eggs were noted on Lamb's-quarters, and at Newark the maggots had begun to mine the leaves. May 22d, plants at several points in New Brunswick were found bearing eggs; in some cases the leaves showed a considerable number. Throughout June, plants bearing infested leaves and unhatched eggs were noted; but toward the end of that month the infestation seemed to diminish, and very little was seen of the insects in any stage.

July 6th, at Trenton, much Lamb's-quarters was noted about a peach orchard; a few of the plants had leaves infested with maggots and a few unhatched eggs were observed; but many plants which had been infested were free at this date. In late August a few eggs were found on Lamb's-quarters at Newark.

Breeding Notes.

Infested leaves of *Chenopodium* and spinach were collected at Little Silver, May 17th, and adults were bred in the laboratory from these as follows:

June 6	10 males,	7 females.	
" 7	11 "	8 "	
" 8	5 "	5 "	
" 9	..	1 "	
" 10	..	1 "	
" 13	1 "	..	(a parasite).

From infested leaves of spinach, beets and Lamb's-quarters collected at Little Silver, May 26th, the following adults were bred in the laboratory:

June	13	39 males,	32 females.	
"	14	33 "	47 "	
"	15-16	18 "	32 "	5 (a parasite).
"	17	2 "	..	
"	18-21	10 "	4 "	22 "
"	26	..	..	2 "

In the above breeding the parasite was bred from infested leaves of all three species of plants.

Life History.

While the above breeding was carried on to determine the species at fault and whether more than one species was present, no effort was made to ascertain the length of the various stages. These, however, have been determined by Dr. L. O. Howard, who gives from 3 to 4 days for the egg stage, 7 to 8 days for the larval or maggot stage, and 20 days for the puparium or resting stage. These periods, nevertheless, vary to some extent, and Professor Bruner gives 10 days as the period required for one specimen to develop from larva to adult.

The life cycle of this species is briefly as follows: The eggs are laid on their sides, singly or in clusters, on the undersides of the leaves. When in clusters they are laid parallel, or nearly so, to each other, and as many as seven have been observed together, although groups of two, three or four are usual. The individual egg measures .03 in. in length, is somewhat oval in outline with rounded ends, has a reticulated surface and is white in color. When laid they must be somewhat viscid on the surface, to remain attached to the leaf even for some little period after the maggots have hatched. As many as 30 eggs have been noted on a single leaf.

As soon as the maggot emerges from the egg it makes its way into the tissue of the leaf and feeds between the upper and lower surfaces or epidermis. At first this mine is more or less gallery-like, but soon becomes an irregular blotch. Frequently several maggots will be found in a single chamber, but when enough food is not obtainable in one leaf the maggots will migrate to others.

resembling the root maggots of onions and cruciferous crops, and when full grown measures 5/16 in. in length. It is whitish, somewhat hyaline in appearance, and in the specimens taken fresh from the leaves more or less of the internal structure is partially visible.

When mature, the maggot generally makes its way to the surface and penetrates the soil to pupate. The pupa, as is the case with all the species in this group, forms within the outer skin of the maggot, which hardens and forms the puparium. This is white at first, but gradually changes to a dark brown, is somewhat oval in outline and shorter than the full-grown maggot.

While pupation generally occurs below the surface, it may take place under the leaves or perhaps other similar objects on the surface or even in the leaves themselves, if they are on the surface. To ascertain the conditions of pupation the following record of some of the breeding jars was noted:

A few leaves of Lamb's-quarters infested with maggots of various sizes were collected at Little Silver, May 17th, and placed in a glass dish without any soil and left undisturbed. Between June 6th and 9th, 12 males and 11 females were bred out, and on June 13th, 1 parasite. July 5th, the dish was cleaned out and it was found that a very few flies had evidently dried up in the puparia without emerging, showing that the drying out of the material had affected the insects to a slight extent.

A small number of infested leaves of spinach obtained at the same time and locality were placed in a similar dish, and between June 7th and 9th, inclusive, 2 males and 3 females were reared.

To determine the depth of pupation in the soil, 4 breeding jars were examined. Each jar contained several inches of damp sand, and in two of them a number of infested leaves of spinach were placed while the other two received leaves of Lamb's-quarters. The following conditions were noted:

In or under the decaying and dry leaves on the surface..........	40	pupæ.
Between surface and ½ inch deep..........................	43	"
" ½ inch and 1 " "	208	"
" 1 " " 1½ " "	156	"
" 1½ " " 2 " "	31	"
" 2 " " 2½ " "	11	"
" 2½ " " 3 " "	9	"
Over 3 inches deep..	no	"

which were not able to find enough substance to mature, made an effort to pupate, but it was noted that the deepest pupæ if anything were undersized. From the above results it is evident that the normal depth of pupation is between the surface and 2 inches.

The emerging flies, save in color, superficially resemble those of the root-maggots. A well developed fly measures about a quarter of an inch in length. The female is olivaceous ash-gray with the legs, save the darker, reddish and these together with the wings, the veins of which are red, give the insects a reddish cast. The males differ from the females by being of a somewhat darker gray and having the forelegs of a similar color, the mid and posterior legs being the same as in the female. As is usual in this group, the eyes meet on the dorsal surface in the males and are separated in the females.

Seasonal History.

Based upon the length of time it takes the insects to mature, which, as already noted, would be about a month from egg laying to adult, and also upon the fact that the species has been observed in the field throughout the season, it has been suggested that there are six or seven broods annually. This, however, has not been determined. Mr. Sirrine, several years ago, found in his investigations in New York, that the insects may hibernate in the pupal stage, and I believe that this is the normal and possibly the only stage in which they pass the winter. From these hibernating pupæ Mr. Sirrine obtained adults as early as mid March, although the majority of them did not appear until mid April. In New Jersey the flies evidently do not begin to emerge until late April and continue ovipositing well through May, and from eggs laid during this period maggots were collected at Little Silver, May 17th and 26th, and flies bred out in the laboratory June 7th to 13th. Some flies of this brood undoubtedly emerged earlier than this and continued to do so for several days later. This irregularity of development would increase as the season progresses, and if the insects continued to breed as rapidly as early in the year they would, toward the end of the summer, be found in the field in all stages of development, at the same time.

It is to be observed from the record of observation, as here noted, that the insects appeared to decrease in numbers toward midsummer, and that when the Sickles farm was visited on August 1st, very little was seen of them either in spinach, beets, or Lamb's-quarters, although they had been breeding abundantly in these plants there early in the season. This, however, seems to be contrary to conditions which were noted several years ago by Mr. Sirrine in New York State, as in his report for that year he states: "Throughout the past summer it has been impossible to find a plant of Lamb's-quarters that did not have some of these maggots in the leaves. During the fall they have attacked the spinach so severely that it was impossible for the farmers to sell their spinach after carting it to market. The injury to beets has not been so marked."

The bad infestation of and consequent injury to the infested plants in the fall of the year has been observed by other investigators, but in New Jersey all the injury to plants noted occurred in the spring or early summer, and the growers report that they have not been troubled by the insects later in the season.

There is another point of interest in this connection. One of the breeding jars in which a number of infested leaves were placed in May, and from which flies had emerged in June, was examined in August, and it was found that the number of pupæ was considerably larger than that of the flies that had emerged. It is true that a number of the maggots, in the collected leaves, which were so small that they had been unable to feed sufficiently to develop properly but had, nevertheless, been able to pupate would fail to mature, while other pupæ had apparently died owing to the immature conditions of the soil in the breeding jar. Nevertheless, a few of the unhatched pupæ appeared, at the time the jar was examined, to be in good condition. It may be that all of the flies developing from this spring brood of maggots do not emerge at the same period; but that while some emerge within the normal time of a month, others lay over for a longer period.

Enemies.

Under the record of breeding it will be noted that two species of parasites were bred, one specimen of *Apanteles,* a new species, and several specimens of *Opius anthomyiæ* Ashm. It is further interesting to note that these were bred from the maggots in all three plants, beets, spinach and *Chenopodium,* and that in nearly all cases they emerged after all the flies had emerged in the same jar.

In his investigations in New York State, Mr. Sirrine observed that dead larvæ were often found in the leaves, and that a common predaceous bug, *Coriscus ferus* L., was apparently responsible for their destruction. The latter was not observed in our investigations, but as it is a common species, it is probable that it, as well as the species of bred parasites, and other yet unrecorded parasitic and predaceous enemies assist in holding this insect in check wherever it occurs.

Food Plants.

It has been stated that the insect was found breeding in beets, spinach and Lamb's-quarters, *Chenopodium album* L., and so far as known these are the only species in which the insect has been observed breeding. They all belong to the family *Chenopodiaceæ,* and it may be that other members of this family will also be found to serve as food plants of this species. At any rate in the various localities where Lamb's-quarters has been observed this insect has been found feeding in it, and from the records of other observers this is also true in other parts of the country. This common and widely distributed weed is apparently the natural food plant of this insect, and hence it is evident that the insect is likewise generally distributed. It is interesting to note that all three of these plants are of either Oriental or European origin, like some other members of the same family.

Injury.

The injury caused by these insects is principally in spinach. This is always used for "greens," and even a moderate infestation would tend to reduce the value of the crop, while a bad infestation would make it unsalable. This would apply equally to beets when the leaves are used in the same way, but in cases where they are grown for the beets the worst injury is in the retarding of development. Sometimes, however, the infestation has been so great, as already noted, that the beets could not be bunched. In New Jersey, as already stated, the injury has only been noted early in the season.

Remedies.

Very little has been attempted in the way of remedial measures. Mr. Sirrine tried spraying the leaves with kerosene emulsion with the result that the leaves were injured while the maggots were apparently unharmed.

Cultivation of the soil for the destruction of the pupæ has been suggested. While some of the individuals would undoubtedly succumb to this treatment it is questionable how large a percentage this would affect. Whether the disturbance of the puparia in itself is disastrous to them is questionable; but appears not to be the case from the following experiments:

Infested leaves of spinach and Lamb's-quarters, collected May 17th, were placed in a breeding jar on moist sand and the jar left undisturbed until June 3d, when the contents were examined, the puparia picked out of the sand and placed in sand in another jar. Between June 6th and 10th, twelve male and ten female flies were bred.

Again on May 26th, infested leaves of spinach were placed on moist sand in a breeding jar and the jar left undisturbed until June 7th, when the contents were examined. The sand, small lots at a time, was placed in water where the puparia floated, were picked out, placed in moist sand and then the sand containing them thoroughly mixed up with more sand and all placed in a breeding jar. Between June 13th and 16th, inclusive, 23 males and 29 females emerged, and June 21st, 2 parasites. And it is to be noted that the proportion of flies emerging to the puparia contained in the breeding jar was as great as where the puparia were left undisturbed.

While the puparia, according to the conditions noted in the breeding jars are normally situated not more than two inches below the surface it is doubtful whether cultivation would be very effective against the pest because of burying them deeply in the soil. Mr. Sirrine has observed that the species is able to emerge when puparia are buried eight inches deep, and I have found the same fact to hold true in the case of the cabbage maggot (*Phorbia brassicæ* Bouche), although puparia of the latter are normally situated at a greater depth than those of this species.

The greatest effect cultivation would have would undoubtedly be in bringing the puparia to the surface where they would be exposed to any enemies and to drying out. To what extent they would be affected by the latter, however, is also questionable. As already noted from a few infested leaves collected in May, placed in two glass dishes without sand, and left undisturbed, flies emerged in June. As the leaves were only few in numbers in each dish they soon formed dry masses, and while this drying was not sufficient to retard some of the flies a few of the pupæ seemed to have been destroyed by it. Under field conditions where the puparia were turned up to the surface and the ground became hard and dry with the puparia exposed to the hot sun, it seems probable that most of them, under those conditions, would be destroyed.

The most important remedial measure is undoubtedly the destruction of the food plants. As already stated Lamb's-quarters is a common and widely distributed weed and occurs plentiful in many places. This should not be permitted to grow on a place troubled by this pest, and every plant possible should be destroyed. If this is done frequently so that the maggots do not have an opportunity to breed, the plants, if few in numbers, may be allowed to lay where they are cut off. If, however, the maggots have had a chance to breed for a few days, it will be necessary to destroy the plants, since in many cases the partially grown larvæ would find enough nourishment in the drying foliage to complete their development. In no case should the cut plants be gathered up in piles unless they are to be at once destroyed. What is said in regard to the Lamb's-quarters applies equally well to infested leaves of spinach and beets.

So far as conditions have been noted in New Jersey, it is suggested that where the insect is troublesome in the spinach an effort should be made to force the early crop so as to get it off before it has had an opportunity to become infested to any extent. In regard to beets it is questionable whether they could not be protected when they are grown in frames, by a cheap cheese cloth covering.

The Periodical Cicada.

Tibicen septen decim Linn.

In 1894 when I recorded the distribution of this brood, then known as No. XII., in New Jersey, I scarcely expected that I would, in 1911, have the opportunity of verifying and extending my observations concerning it. It is a remarkable example of the uniformity of nature's processes that, absolutely on time, seventeen years after the records made, these Cicadas appeared in practically every place where they had been previously observed and in practically similar numbers.

Since previously writing of these insects there has been a renumeration of the broods by Mr. C. L. Marlatt, and this old Brood XII. is now Brood II., and will be so referred to whenever necessary.

August 1st, 1910, to advise orchardists, a circular of warning was issued and distributed to the entire bulletin list as well as to all the news and other papers issued in the State. This was generally reprinted and called attention to the distribution of the insect, to the probable dangers to be apprehended and suggested care in pruning and setting out orchards in localities where the insects were known to be due in large numbers.

This resulted in considerable correspondence and many questions were asked concerning danger in specific localities. In general, I advised planting in long cleared areas, in those sections where previous reports were negative, and where the distribution of the English sparrow was such that a moderate infestation would probably be cared for. I found fruit growers generally inclined to take a chance and to risk setting out trees rather than lose a year, and in most localities I did not discourage that, recommending only that the trees be either very severely or not at all cut back. But I did in all cases discourage new settings on recently cleared land in infested areas.

Pupæ were received from correspondents here and there throughout early May; but there was no general approach to the surface until about the middle of the month. The first regular emergence was observed May 19th at Husted, Cumberland county, by Mr. Harry B. Weiss, and thereafter almost every day brought a record—May 25th being perhaps the date of first general emergence throughout the State. By June 10th the brood was out, copulation was general and egg-laying had begun.

June 8th, Mr. Stafford collected both sexes infested by the fungus and with abdomen dropping off, and thereafter infested specimens came in greater or less numbers from all localities. This peculiar disease, due to *Masospora cicadina* Peck, undoubtedly lessened the numbers of these insects without, however, materially reducing the numbers provided for the next brood.

Throughout June the song of the males could be heard; but in decreasing volume toward the end of the month, while the evidences of egg-laying became ever more obvious, and little colonies, theretofore unnoticed became noticeable. Not until after July 19th did the last examples disappear from large colonies, and the first developing larvæ from eggs were not found until the last days of August.

Observations Made.

The entire staff was under orders to note all Cicada appearances and other facts concerning them, throughout the season.

Mr. E. W. Stafford was especially assigned to the vicinity of New Brunswick and to the regions round about Vineland, in Cumberland county, and High Bridge, in Hunterdon county, because the line of special investigation assigned to him kept him for a large portion of the summer in these localities.

Mr. Harry B. Weiss was especially assigned to the southern part of the State as a whole, because of some experimental work to be done at Husted, in Cumberland county, and because in the course of his nursery inspection work during August he covered almost every southern county to a greater or less extent.

Mr. Edgar L. Dickerson was, in the same way, especially assigned to the more northern counties, because the nurseries in that area were his especial care during August, and because during early July he made a carriage trip of two or three days through portions of Morris county.

Mr. Charles S. Sharp, as bee inspector, covered a large area in the State rather fully, and he was instructed to turn in memoranda of all positive observations.

Mr. Herman H. Brehme covered all the shore points from

Newark to Beach Haven, and turned in all positive observations made during the season.

Mr. Henry H. Brehme investigated in detail the occurrences in the vicinities of the cities and towns of Essex and Union counties and noted, interestingly, in several instances the results of sparrow attack on the species.

Mr. H. F. Smith was sent over the lines of the Susquehanna and Western and D., L. & W. Railroads to observe infested points after the effects of egg-laying had become obvious, and Mr. R. S. Patterson was in the same way sent over the Belvidere Division of the Pennsylvania Railroad for the same purpose.

For myself I have been in almost all parts of the State except the extreme north, either by train or in a motor, and my own observations are simply as supplements to those of my assistants. It is fair to say that except where especially noted lack of definite records can be considered good evidence that the insects did not exist.

Injury Done.

There have been the usual reports of excessive abundance, of trains and motor cars having been stopped and of drivers or passengers in carriages having been attacked, but on the whole there has been less of this than in any previous infestation.

Some, even serious, injury has been done, but it has been very local. The worst trouble has been in a section of Gloucester county, where on recently cleared land, immense orchards of apples and peach have been set out. One area of 30,000 trees is practically ruined by the egg punctures. A small number of trees two years out were also much injured and some of them were ruined. There was some injury of that kind almost everywhere; but on the whole not so much as might have been expected. Another kind of injury occurred on bearing trees, where the terminal twigs were stung and weakened so that they broke under the weight of the growing fruit. On one six-year-old peach orchard almost the entire crop was lost in that way, and that, of course, meant a direct and severe money loss, besides the injury to the trees.

Besides the orchards, raspberry plantations seem to have been the chief sufferers, but on these the injury is very temporary and will be completely worked out by the end of the season.

On the whole, while a few individuals have been very hard hit, the actual injury caused by the Cicada has not been very great, taking the State as a whole. It should be added in this connection that no injury at all was done by feeding; only by the egg-laying punctures.

The Dwarf Race.

Cassinii Fischer.

With almost every appearance of this species a certain percentage of specimens occur that are smaller than the normal form and show other peculiarities that indicate a different species, while agreeing absolutely in habits and methods of work. They seem to herd by themselves to some extent, are usually noticed early in the season and are subject to exactly the same sort of enemies and diseases.

They were noticed this year in Bergen, Passaic and Middlesex counties, and all the observers from whom I have records agree that the song of this type was recognizably distinct from that of the normal form, and that they seemed to run in small colonies by themselves. There is a very general inclination on the part of these field observers to recognize a distinct species, and there is sufficient structural difference in the sexual characters to make this at least a probability.

Chimneys.

These are always local, and have been described at length and figured in my reports on earlier broods. In 1911 they were reported from Bergen county, along the eastern slope of the Palisades, from the southern bank of the Raritan river and from a small area in Gloucester county, where I saw them myself and where they were remarkably perfect.

Natural Enemies.

The fungus disease, *Masospora cicadina* Peck, already referred to, was universally present, and is, no doubt, the most wide-spread general check to the increase of the insect. It comes early enough to prevent reproduction in a large percentage of cases; but seems to favor the females by passing them by for males, and by reaching its climax of efficiency *after* oviposition is well under way. The astounding thing is that the abdominal viscera of the Cicada are of so little importance to it that specimens that have lost that part altogether nevertheless fly about and live on, apparently as happy as ever.

Next to this fungus the sparrows did their share in reducing numbers, and since they began with the first specimens that appeared and kept up the fight continuously, it amounted to practical extermination in some city and town localities.

There is also an enormous mortality in the eggs laid in the twigs. Hundreds of twigs were cut open during the early part of the season, and a very large percentage of collapsed eggs was always found. From observations made this year and previously I believe that much less than half the eggs laid in the branches ever develop into larvæ.

The next large brood of this insect is due in New Jersey in 1919, while the next occurrence of the present brood, No. II., is due in 1928.

Occurrences in Detail.

To bring out more in detail just where the insects appeared during 1911, and how this compared with the records for 1894, the following details are given by counties for convenience and future reference:

Bergen County.—In 1894 the record was: "They occurred throughout the whole of Bergen county, and were especially reported from Tenafly, Carlstadt, River Vale and Mahwah."

During 1911 this distribution was confirmed and actual observations showed the insects present from Fort Lee northward to the New York line along the top of the Palisades and on both slopes. There were none in the Hackensack valley and in the low marsh areas; but on the highlands west of the valley they reappeared, extending northward from Rutherford and more or less local. At Rutherford there were a few only as early as May 25th, and on some farms to the north none at all were observed. They were local at and near Ramsey, while at and near Westwood there were millions of them in some places.

Quite a bit of injury was caused on some localities on apple and peach, the latter suffering much more severely.

A characteristic feature in this county was the occurrence of the small variety in great numbers, on the summit and on the talus from Englewood to one mile beyond Alpine, in patches of small extent, where they were observed by Mr. Sleight and others of the New York entomologists.

Chimneys were observed by the thousands at Alpine dock and one mile north along the clay slope between the river and the rocky talus, by Mr. Sleight, and at other points in the same region by other observers.

Passaic County.—In 1894 they were reported from Paterson and from the Greenwood Lake districts, while negative reports came from the southwestern portion.

During 1911 this range was much extended and probably includes all the highland in the county, though, of course, not to an equal extent. At Paterson they appeared May 25th, 26th, and became excessively abundant in the Totowa section. From this point they extended abundantly along the line of the Greenwood Lake Railroad to Little Falls, and covered the lake district. Along the line of the Susquehanna and Western Railroad they extended to the Morris county line. At Pequannock they did serious injury on all fruit trees. They occurred throughout the Lake Macopin region and for about six miles northward very abundantly. At Hackensack the insects were reported June 1st, and that gives a pretty general distribution throughout the county.

Though it is known that the insects were not uniformly distributed, I have no definite reports of non-occurrence over any considerable area.

Sussex County.—In 1894 they were reported from Huntsburg and Papakating only; negative reports coming from a number of other points. In 1911 very little was added to this. They were definitely noted at Sparta and at Newton where, indeed, they were accused of stopping railroad trains on June 23d. "The locality known as the narrows near Newton is alive with them, and their musical hum can be heard for a mile." It is more than probable that they appeared in other localities in this county, but there certainly was no uniform or general distribution that could be noted along the ordinary lines of travel or that attracted the attention of the department correspondents.

Warren County.—In 1894 the insects were reported at Rocksburg only. In 1911 they were noted at Washington, at Hamburg, June 1st and 2d, and at Port Murray along the line of the D., L. & W. Railroad. Negatively, there was no appearance of the insects, except where above noted, along the lines of either the Belvidere Division of the Pennsylvania Railroad, the Susquehanna and Western or the D., L. & W. Railroad. There were other isolated localities probably, but certainly no general distribution or great abundance of specimens.

Morris County.—The report for this county in 1894 was that it was covered in all its parts, but very irregularly, the reports of greatest abundance coming from Boonton and the eastern districts. The general distribution was confirmed in 1911, but more definitely so far as actual distribution was concerned.

They occurred all along the line of the D., L. & W. Railroad to Lake Hopatcong and at Morristown and Morris Plains were said to have been so abundant that their decaying bodies created a stench. Along the line of the Susquehanna and Western they were equally in evidence from Newfoundland and Charlottesburg to Sparta in the wooded areas on both sides of the road, and they were plentiful on the Newark watershed. They were especially reported from Chatham, Denville and Dover, and from that point to Wharton. So also from Mendham, Millington, Mt. Tabor and points north and south of Dover.

Mr. Dickerson reports, on a drive from Chester, that on the hill between Chester and Flanders (Pleasant Hill) the insects occurred in patches, but none at Flanders itself. They were present on Mt. Olive, but there were none at Budd's Lake.

In this county considerable injury was reported in peach orchards, but as usual the injury was irregularly distributed. Perhaps nowhere else were the insects more in evidence along the main lines of travel than here, and reports covering these lines are numerous.

Essex County.—In 1894 this county was reported as infested everywhere in almost equal abundance, and with slight modifications that report may stand for the present year. Whatever modifications have taken place are due to the increased numbers of sparrows and the cutting of woodlands. Nevertheless, in almost every town and village the insects were found and reported, and throughout the wooded slopes of both ridges of the Watchung mountains, their song was heard and their injury was noted.

The earliest date was at Essex Fells on May 20th, and thereafter every day produced a new record until their presence was universally recognized and attracted no further attention.

Hudson County.—Reported in 1894 as universally covered except for the flats and marshy portions, along the Palisades and down to Bayonne. Very little Cicada ground now remains in this county. Every available area along the Palisades has been built up and sparrows are on the alert for every unfortunte Cicada. Down toward Bayonne nothing is left for them, and practically the only bit of remaining highland suitable for their propagation is in the vicinity of Snake Hill. That is about all that remains of the once extensive colony in this county, and at the rate that changes are now proceeding there will be very little chance for those due in 1928.

Somerset County.—In 1894 my reports from this county were scant and indicated that the insects occurred in a few localities only. The reports for 1911 are more complete, but indicate only a local and somewhat scattering infestation, chiefly in the northern portion. They were abundant in Washington Valley back of Pluckamin and extended all the way along the road to Basking Ridge. They occurred in spots all the way from Bound Brook to Bernardsville, and sometimes in considerable numbers, but there was no general distribution. Scattering specimens were noted at Somerville and Raritan and there was a considerable colony in the oak woods west of Raritan.

Hunterdon County.—In 1894 all but one report from this county were negative; the one exception being in the northwestern corner. In 1911 I was a little more successful. Mr. Stafford found the insects in some numbers at and near High Bridge while engaged in work in the peach orchards. They extended throughout the hills southeast toward Lebanon, but were not noticeable along the lines of the railroads through here. Mr. Dickerson found egg-punctures in the peach nurseries at Fairmount, near the Morris county line, but nothing was found at White House, New Germantown, nor in the other peach nursery districts of this county. Along the line of the Belvidere Division of the Pennsylvania Railroad, traces of the insects were seen at Lambertville, they were rather more abundant at Stockton and Ravenlock and petered out before the northern boundary of the county was reached. There were none at Ringoes.

Union County.—In 1894 "Union county was generally covered, reports showing their presence everywhere." This is still true in a general way, but to a much reduced extent. I saw the first examples coming up in the streets of Roselle, May 25th, a little before dusk, and there were some in all of the towns along the line of the Central Railroad. At Fanwood, indeed, they were abundant. So along the line of the D., L. & W. through this county and notably at Summit. In the outskirts of Elizabeth and at Springfield egg-punctures were found in the nurseries at inspection time, although not in great numbers. At Rahway detached wings were mostly in evidence, the Cicadas themselves having been destroyed by the sparrows. It is safe to predict a much reduced brood for 1928.

Middlesex County.—In 1894 they were recorded as "irregularly distributed, more plentiful north of the Raritan river and petering out toward the south and west. Along the Raritan river I found them abundant nearly to Perth Amboy and petering out at Bound Brook. They were in patches to Jamesburg and on the line of the Amboy Division of the Pennsylvania Railroad, and extended into Monmouth county." Nineteen hundred and eleven has extended this distribution somewhat. At New Brunswick the insects were in the outskirts to the south, plentiful at the College Farm, where they were collected and observed by Mr. Stafford. Along the line of the Pennsylvania to the northeast colonies were observed on both sides of the road in patches of woodland from Stelton to the Union county line. From New Brunswick southwest along the same line not a colony was observed to the Mercer county line. Very little was seen along the south bank of the Raritan toward Bound Brook, but along the north bank colonies were noticeable all the way up to the county line. From Rahway to Perth Amboy and along the north bank of the Raritan from Metuchen to Perth Amboy colonies were in almost every patch of woodland and along the south shore of the Raritan they were abundant in the scrub-land to South Amboy and beyond it to the banks of the Cheesequake. From New Brunswick to Old Bridge an occasional colony was seen in the woodland, and these became less numerous to Dayton and Jamesburg in one direction and Matawan in the other. Between Jamesburg and Dayton a small colony was found, and then to the Mercer county line nothing more occurred. It was therefore in the eastern half of the

Monmouth and Mercer county lines they petered out.

May 26th marked the date of first emergence on the College Farm, and on the 27th numerous wings indicated that the sparrows were already at work.

June 17th, Messrs. Dickerson and Grossbeck collected along the river east of New Brunswick, finding the small form in considerable number as well as some areas where chimneys had been plentiful although now pretty well broken down. At this date also the fungus disease was getting in its work on both sexes, and many specimens had already lost part or all of the abdomen.

In the Milltown area Mr. Stafford collected egg-punctures and determined that the young began to emerge and drop to the ground during the last days of August.

Mercer County.—In 1894 I noticed them only on the road to Hightstown and had no positive reports of their presence elsewhere. This same small colony was again noticed between Hightstown and Yardville; scattering signs were noted in the vicinity of Princeton and on the New Brunswick road, and a very few were reported along the line of the Belvidere Division, near the county line. Otherwise the country was almost free from them along all the railroad lines and along the main roads over which I rode in an auto on four separate occasions.

Monmouth County.—In 1894 my reports from this county were mostly negative, but I found punctured twigs in a number of localities in the eastern portion. There is not much more to add for 1911. There was a large colony near Matawan, and a still greater one at Cliffwood, where raspberry canes were severely injured on a small area. But there was nothing in the woods back of the shore from Red Bank to Point Pleasant, and nothing in the Freehold region nor in those sections of the Pines seen by me. It is possible that near the Ocean county border there may have been some small colonies toward Lakewood, but there was no definite report.

Ocean County.—In 1894 they were recorded in small patches here and there, Toms River being the worst infested portion, and another center existing at Cassville. As it happens neither of these localities was again reported in 1911, but there was a considerable area about Lakewood that proved to be infested. Mr. Dickerson found them local for a distance of five or six miles on

Cassville. Mr. Sharp found them south of the town "thick as flies on a cow," and oak, chestnut and fruit trees badly hurt. Mr. Davis found them in the gravel hills at South Lakewood, and west of Lakewood; at Ridgeway and not far north of the Ridgeway river. None are in the true pine barrens. I saw none at Ocean Gate, along the south shore of Toms river, nor along the line of the railroad from Barnegat pier to Camden, so far as the line extends through Ocean county.

Burlington County.—In 1894 I reported it spotted by colonies here and there, one of them near Pemberton, but as a whole the reports were negative. I expressed the belief that toward the shore there would be more colonies. The season of 1911 added nothing to our knowledge in this direction; on the contrary, not a single positive record was received from this county despite the fact that both Mr. Weiss and myself traveled through it rather extensively by railroad and auto. There was certainly nothing north of the Pine belt and nothing along the line of the Delaware river. Several cranberry bog owners whose marshes lie in the pine belt of the county, assure me they saw nothing of the insects, and while there may be some infested gravelly areas they must be few and small.

Camden County.—In 1894 the insects were reported from Pensauken; I observed them along the lines of the Atlantic City Railroads to the Atlantic county line, but local and in no great numbers. At Clementon they were abundant enough to cause injury in chestnut groves. Except for Pensauken, where nothing was found, these localities were verified in 1911. There were millions of them at Almonesson, and at Blue Anchor they were seriously injurious to raspberry canes. They extended from Florence to Williamstown Junction and along that branch into Gloucester county. They appeared along the road about four miles east of Haddonfield, and the distribution was spotty on gravelly areas throughout the county.

Gloucester County.—In 1894 they were reported from Franklinville, and I saw them at several points north of that place along the line of the Cape May Railroad. In 1911 they were noted near Woodbury, at Malaga, and along the line from Williamstown to Glassboro. There were several large colonies within a few miles of Glassboro, and very serious injury was caused in some localities—as many as 30,000 young fruit trees were killed or crippled in one district alone. Some bearing orchards were badly hurt, and this applies to apple as well as peach. Many square miles were covered by the insects, yet there were many gaps also and many acres of orchards were absolutely unharmed.

In some localities some of the best chimneys of the season were found and good samples were obtained.

Atlantic County.—In 1894 was reported as infested throughout, but irregularly. I found them all the way from Hammonton to the coast along the Atlantic City Railroad, and at other points along the Cape May county line. This is pretty nearly the truth as shown in 1911, but Mr. Rider pointed out to me that the infestation was practically confined to gravelly knolls or areas, and that none occurred in the sandy barrens. This was beautifully illustrated during the middle of August when I made a little trip into the cranberry country with Mr. Rider and through a portion of the pine areas southwest of Hammonton. There was also an area of infestation along the course of the "fast line" from Pleasantville to Somers Point, though the points were scattered and usually small except at Linwood.

Cumberland County.—In 1894 this county was compared to Atlantic as to manner of infestation, specific points mentioned were Bridgeton to Millville and the line of the West Jersey from Vineland to Cape May county. This distribution was verified in 1911. Mr. Weiss found them as early as May 19th in the vicinity of Husted and about Bridgeton, and they occurred along the line of the Central Railroad between that city and Rosenhayn in all the wooded sections. Mr. Stafford watched the species at and in the vicinity of Vineland, and found several large and scattered colonies there. He also observed them along the electric line between Malaga and Newfield and along the main road to Millville.

This somewhat amplifies the previous record and points to the correctness of the general conclusion that all suitable localities were more or less infested.

Salem County.—In 1894 this county sent negative reports except from the narrow strip lying east of Friesburg, which is close to the Cumberland county line. During the season of 1911 Mr. Weiss found a few infestations between Elmer and Palatine, but not an office correspondent from this county referred to them. The county just escapes having no part of this brood within its borders.

Cape May County.—In 1894, all save the low lands supported great numbers, and at Woodbine the insects did perhaps more real injury than in any other part of the State. Practically this same record stands for 1911. Mrs. E. S. Starr of Ocean View observed the insects for several miles in her vicinity. Mr. Weiss made the trip to the shore over the West Jersey to note conditions, and Mr. H. W. Wenzel of Philadelphia sent me a record of his observations. Definite records extend from Tuckahoe into the peninsula gradually petering out to the shore. Woodbine and Dennisville in plenty. Sea Isle Junction and Wildwood Junction a little. Between Seaville and Swain in patches. South Seaville, in the woods everywhere. Mount Pleasant in enormous numbers. All the wooded parts of the peninsula in gravelly lands.

The Plum Curculio.

Conotrachelus nenuphar Hbst.

During the summer of 1910 the Plum Curculio attracted more attention than any other insect of horticultural interest in New Jersey; principally because of Mr. Blake's insistence concerning its importance in the peach orchard. I had, of course, a very extensive acquaintance with the species from almost all points of view and was not inclined to underestimate its importance; but I must confess that I could not work up any very great excitement over a money loss in peaches due to curculio injury. Nevertheless I followed out Mr. Blake's line of argument with experimental work, and am free to admit that given his premises and theories of marketing, the heretofore negligible injuries of the curculios assume an importance in some cases that from the money standpoint completely overbalance everything previously comprehended. But even here not altogether, nor in all cases.

Mr. Blake sells his fruit upon its appearance in the market and expects fancy prices for fancy fruit. Naturally every defect counts against him, and every curculio egg or feeding puncture that mars the cheek of an otherwise perfect fruit, detracts from the price. When some of the glorious fruits produced by him

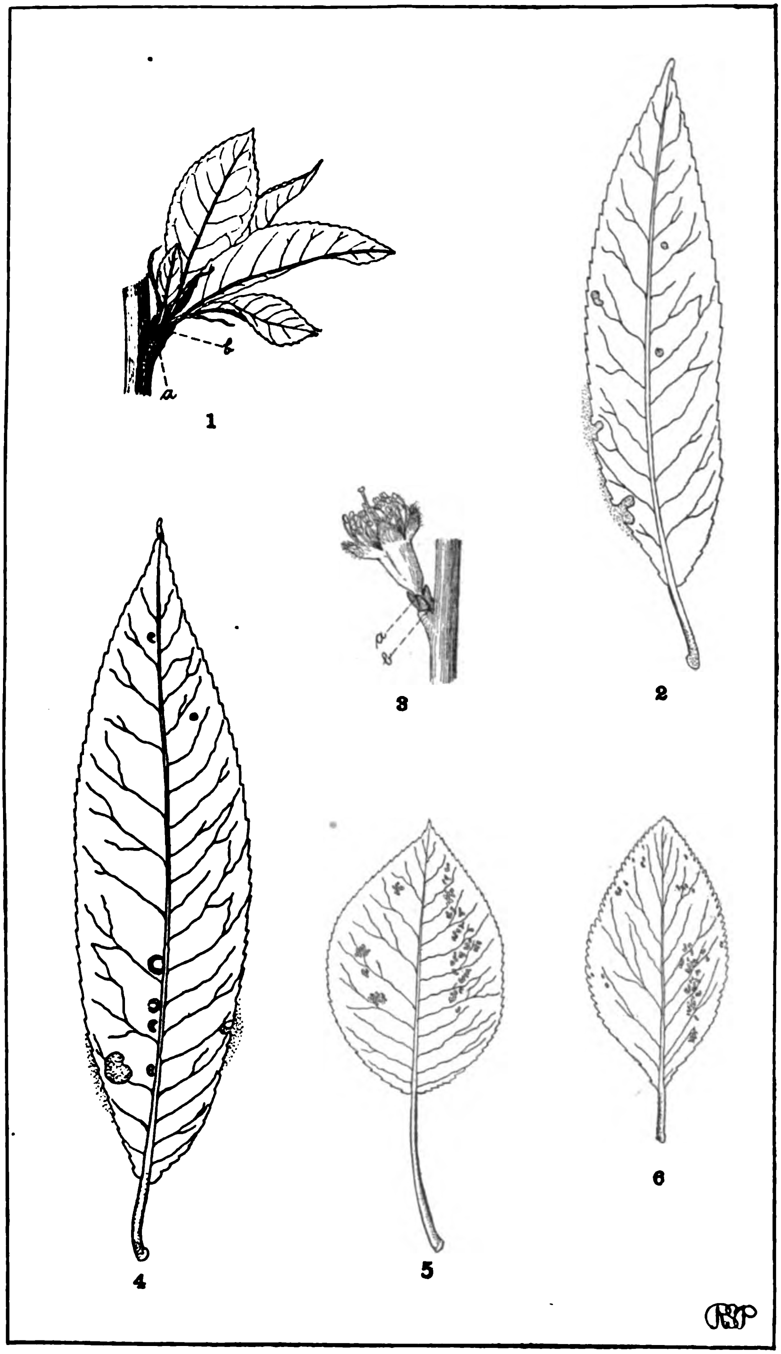

Figure 5.

1. Young shoot on peach tree on which adult Curculios are feeding at *a* and *b*. At both points holes were bored down to the depth of the Curculio antenna.
2. Peach leaf, showing surface feeding of Plum Curculio.
3. Peach blossom on which adult Curculio had been feeding at *a* and *b*. At both points holes were bored down to the depth of the Curculio antennæ.
4. Peach leaf, showing surface feeding of Plum Curculio.
5. Apple leaf, showing surface feeding of Plum Curculio.
6. Plum leaf, showing surface feeding of Plum Curculio.

have been seen, a curculio defect easily becomes a personal offense and naturally enough the question arises whether something cannot be done to prevent this trouble.

The matter becomes simplified because in years of normally excessive crops, very few fruits are injured at picking time, and they are mostly of the earlier or earliest varieties. So far as curculio injury is concerned a crop will run sometimes all day with practically no appreciable injury of that character. I sat on one occasion for two hours watching the facing of firsts and extra choice as they came up without noting a single reject for curculio injury, although the variety was Carman, which is among the susceptible ones.

Mr. E. L. Dickerson, Mr. J. A. Grossbeck and myself were all interested in the work, as were Mr. Blake and his assistants, and we secured from the Experiment Orchards at Vineland perhaps the largest lot of specimens of dropped peaches for critical examination ever examined at one time. Most of the work and all the tabulation finally fell to Mr. Grossbeck's part, and that appears in the delayed pages of the report for 1910.

There were a variety of other questions that this gave us an opportunity to settle, or at least to make a stab at. How much is rot dependent on this insect and how generally is curculio and rot associated.

Mr. Blake and his collaborateurs were good tillers of the soil, good sprayers, and the numbers of our counts were well over 5,000 of which nearly one-half dropped from the trees to the benefit of the trees themselves. Over 500 dropped simply from defective pollination or inherent weakness, and of those on the ground nearly 800 had started to rot without any trace of curculio feeding or other mechanical injury to depart from. There are a number of other very interesting facts shown in those tables, and when they are carefully compared with some of the tables shown in this report the facts will show up new life and new interest.

At all events the outcome of the investigation was such that I felt sure that there was a season's work in the orchard for a man who devoted his time to nothing else, and as Mr. Grossbeck had unfortunately left me for a better position and Mr. Dickerson contemplated doing so, I sought another man afield, and thought I had found him in Mr. Ethelbert Withrod Stafford of Guelph College, Ontario, during the winter engaged with Professor Wash-

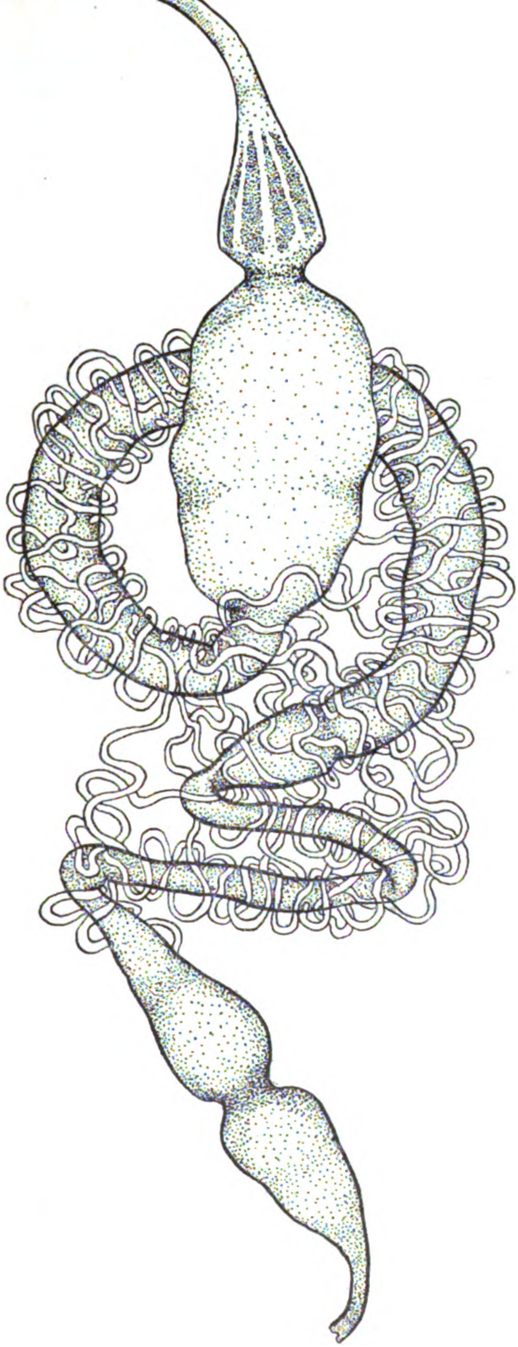

Figure 6.
Digestive system of Plum Curculio; very much enlarged.

The smaller orchard is one year older and furnished the supply made use of, chiefly, in 1910.

Under totally different conditions there is an Experiment Orchard on the Governor Voorhees farm at High Bridge, which was used by Mr. Blake as an addition and a check to work done at Vineland, but was resorted to by Mr. Stafford merely for purposes of comparison and not for additional information.

May 3d and 4th collections were made in orchards around Vineland; not a great many beetles were found anywhere, most of them around outside rows even in apple orchards, only isolated specimens in inside rows of peach orchards. Three pairs of beetles in copulation. Weather cold and windy, most peaches have shed petals, a few apple trees are in bloom, about one-half the plum petals have fallen.

May 5th, at High Bridge, peaches, apples, plums, pears and cherries were jarred, but no adult curculios were found on them at all. Nor were any hibernating adults found, sifting in woods at both sides of Experiment Orchard. Plums and cherries in full bloom, peaches coming into bloom, apples and pears swelling.

May 10th, beat twice around the Experiment Orchard and a few southern rows, also in interior. Got 22 beetles, 19 of them within three trees from edge of orchard. Beat pears to south and east of Experiment Orchard. On 3 of south side, got 8 curculios. Five southern—most on east side yielded 5, the twelve trees on the north yielded not one.

Mouth Structures.

The mouth structures of the plum curculio are small and little attention has been paid to them, but they are interesting, and they are in all respects functional. Since it has been shown that the insect even does a great deal of feeding, it behooves us to know that practically all kinds of surface and digging work is within their power. The mandibles are of the typical gouge shape, with two sharp and one flat inner tooth fitted for taking out surface layers of cells, situated at the end of the proboscis or rostrum and actuated by powerful tendons and levers extending well up the side of the head and hinged by a relatively powerful pin to the framework of the head itself.

Instead, therefore, of having rather a weakly developed mouth structure as is sometimes left to be inferred, the structure is really a very powerful one, and as far as mandibular work is concerned there is no sort of feeding on any kind of plant frequented by this insect which is beyond it.

On Plate 5, Figs. 2, 4, 5 and 6, the usual types of feeding on the surface of the leaf are shown, and these are for ordinary food work only. At Figs. 1 and 3, *a* and *b*, on the same plate, are illustrated peach buds and shoots also punctured for food, but in a different way. In both cases the feeding punctures penetrate deep into the plant tissue and tend to kill bud or shoot. They do not necessarily do so, but they may do so, and the feeding at that early period is to be considered a source of danger.

At 8 on Plate 8 is a normal feeding puncture on a fruit, while at 7 and 9 on the same plate are egg punctures with an egg unplaced and one placed to show the positions.

Inside the mandibles and so very materially smaller that they are completely concealed, are the soft fleshy maxilla, the inner lobes of which are hairy and furnished with soft spatulate processes; they are in no real sense assistants in the work to be accomplished by the mandibles.

So the small fleshy labium which lies almost concealed between the base of the maxilla are of little real functional use in the mouth structure.

We have become used to looking upon the Curculio as rather a sluggish insect, and perhaps with some sense of justice; but it certainly is not sluggish when it first makes its appearance in the orchards and on the trees. I had a series of specimens under almost continuous observations for several days, and their almost ceaseless activity was a source of constant surprise to me. To be sure they had just come out of hibernation, they were just copulating, they were just beginning to feed and really beginning to live, which may make a difference even in a Plum Curculio; but the activity was there and the rapidity of feeding. And the digestive system responded. The excretions came in strings and pellets, so that within 24 hours the full length of the digestive system must have been filled and emptied at least once. The digestive system, shown on page 471, is simple. The maceration of the food is chiefly done by the mandibles, but the mechanical condition is a little bettered by a series of diagonal chitinized plates forming a small gizzard. This intense activity on the part of the adult curculio does not seem to last more than a few days at most. Perhaps it is only while the insect rouses from its winter nap, gets its alimentary canal filled and its vital functions in other directions started. When it is observed feeding in growing fruits there is certainly none of that nervous activity observable when it is feeding in buds, and then it clasps rather tightly, requiring somewhat of an effort to dislodge it.

Furthermore, it becomes worthy of notice that whereas at its first appearance, the matter of food is the principal one under investigation by the beetle, as the season advances the matter of food and of egg-laying is to an extent conjoined. Just how much those processes are altogether joined we do not yet know, and we have every reason to believe that there is considerable variation in the fruits and perhaps even in individual beetles. Certain it is that sometimes in counts made we will find feeding punctures only with remarkable uniformity, while in other cases it is rare to find a puncture not associated with an egg. Perhaps plums have fewer feeding punctures than other fruits, and peaches certainly have more feeding punctures comparatively than any other fruits known to me.

Apple feeding seems to be for nourishment and for oviposition in about even parts from my own experience. As a matter of fact while a female is laying eggs, I doubt whether she does any considerable amount of outside feeding, and a typical feeding puncture in an apple fruit, Plate 8, Fig. 8, is unlike an egg-puncture in a similar fruit—compare Figs. 7 and 9.

The egg crescent has been often enough described, but the average grower does not seem to understand its purpose nor its relation to the egg itself.

Two structures are really involved, the mouth parts to eat out a crescent-shaped flap and the ovipositor or egg-laying tube to put the egg into place. The egg of the Plum Curculio is really a very soft fragile structure which can stand little pressure of growth from young fruit.

The beetle, therefore, with its elegantly adapted mandibles gouges out in the plant tissue enough of the texture just below the surface of the skin to loosen a little flap and remove a pressure, like Figure 7 on Plate 8, which just shows the inner

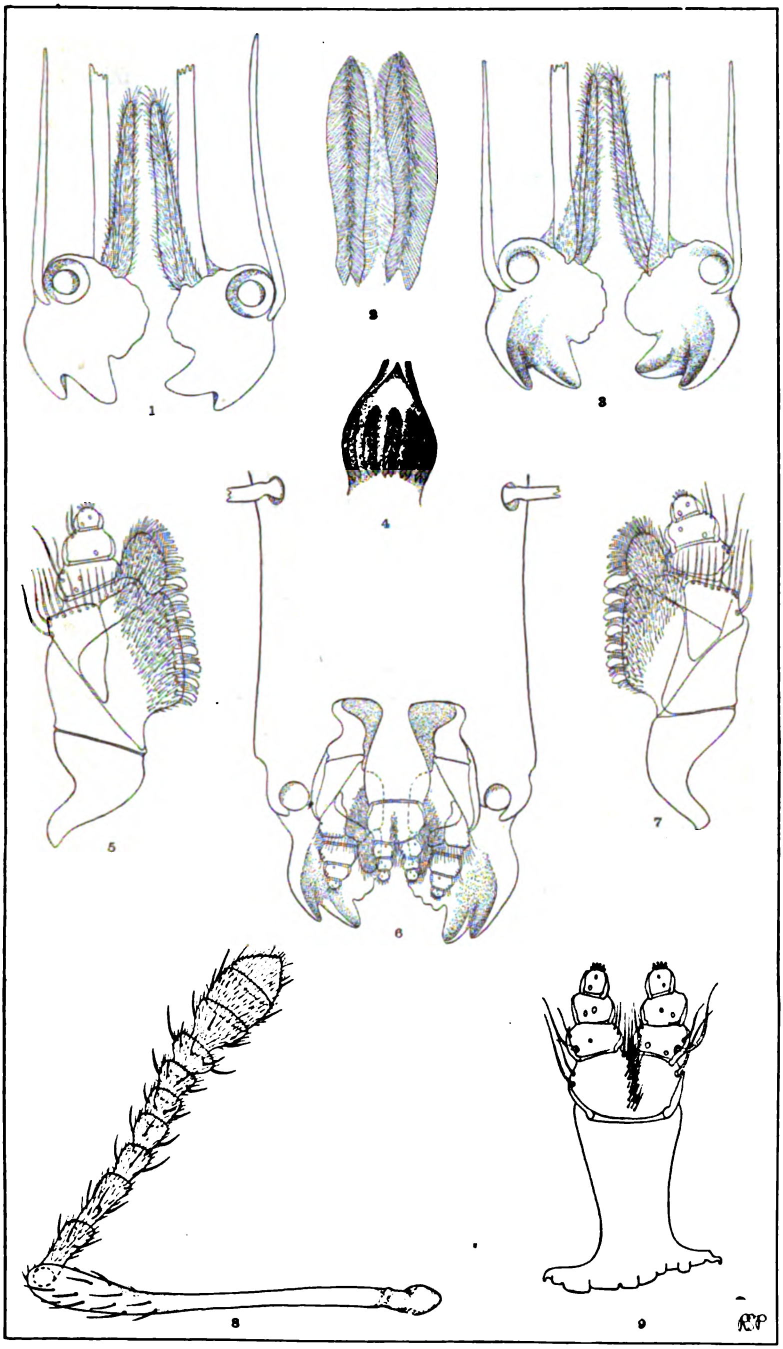

Figure 7.

1. Plum Curculio; tip of rostrum from below showing the convex faces of the gouge-shaped mandibles from below.
2. The thin diagonal series of plates found in the gizzard of the true digestive system on pl. 7, Fig. 4; very much enlarged.
3. Plum Curculio; tip of rostrum from front, showing the concave cutting face and gouge-like structure. This structure suffices to shelter the remainder of the mouth parts and to equip the insect for its work in the orchard and on the trees.
4. Gizzard of the digestive system as a whole. Pl. —, Fig. 6.
5–7. Maxillæ of Plum Curculio adult from the right and left sides.
6. Mouth parts of Plum Curculio *in situ* from front, showing all parts in relation to each other and in proportionate size.
8. Antenna of Plum Curculio.
9. Maxilla of Plum Curculio.

texture or cavity in section. That leaves outwardly just below the surface a little tough flap of skin tissue.

At the tail end of the body the female curculio has a rather broad, sharp, egg-laying tube or ovipositor. Seen under the ordinary hand lens this appears slightly roughened merely; seen under a high powered dissecting microscope, the upper surface is covered with little triangular plates like 4, 5 and 6, on Plate 8, and this is an ideal structure to force down into that little flap left by the mandibles. And as it is forced down and withdrawn it takes out just enough of that plant pulp remaining to make a comfortable opening for the curculio egg, without any pressure whatever. Plate 8, Fig. 9, shows the egg in position in a plum.

The Reproductive System.

The Plum Curculio produces a relatively large number of eggs over a considerable period of time by means of a small outfit of ovarian tubes. There are just two pairs, furnishing indeterminate numbers, nutritive material all at ends. There is no development in the summer or fall, and copulation takes place in April or early May. But from that period development is rapid, and 40 to 50 ova in various stages become normal in a healthy individual. I have not tested the capacity of a single female, but have seen thirty eggs daily recorded, which seems just a little difficult to credit when all the labor involved in laying them is considered.

The drawings supplied must be relied upon for further details on this point, which was not carried out in greater minutia, and so for the comparisons, which it was intended to make with the structures of related males.

May 11th, at High Bridge, 19 beetles were collected from the outer two rows of the experiment orchard, and other beetles were collected here as well, but always outside rows.

May 12th, peach and plum had shed their blooms on the College Farm, and apple blossoms were dropping. Beetles were obtained in small numbers from each of these trees. Again, on May 13th, collected 40 curculios around the edges of the orchards and none in the body of the orchard itself. Nor were beetles had recently come on for feeding and propagating purposes.

May 17th, went to Vineland, to old orchards from which shucks were falling generally, to collect material. Found beetles throughout the orchards now, but yet fewer in the center than around the edges. Found egg punctures now in some of the fruits and eggs in some of the punctures. At this time the trees to be examined in the peach orchard were selected out, and this particular feature of the work was especially looked after; the other work was left more or less discretionary with Mr. Stafford, and his records are in consequence rather vague. They do show, however, that he examined a large amount of fruit and foliage, determined that a very large amount of material was actually eaten by the curculio and that on plum and cherry practically all the fruit was destroyed or seriously injured. A sufficient record of this is also preserved at New Brunswick.

At this time no eggs at all were found in pears, few in apples and few in peaches, but more where the other fruits were considered; galleries in peaches could already be demonstrated in occasional specimens.

The first spraying of arsenate of lead only had been alread
made in the peach orchard on or about May 1st, omitting o
the small series of trees collected as checks by Mr. Stafford. T
is really a misunderstanding even here. Mr. Stafford clai
no check trees were left, and that every tree in this orc
ceived the arsenate of lead mixture. Mr. Blake's men
the actual work, deny this. They claim that this li
15 trees was left altogether unsprayed and receive
secticide nor fungicide.

The second spraying was received May 17th an
sisted of arsenate of lead and self-boiled lime a
second series of 45 trees consists of trees so tr

The third series is similar in number and
ings of the orchard. The first of arsenate
ond combining the self-boiled mixture w
third forming the regular commercial
orchard at large, and concerning whic
be consulted; in fact, except as to t
and as to the details of insect ex
must dominate.

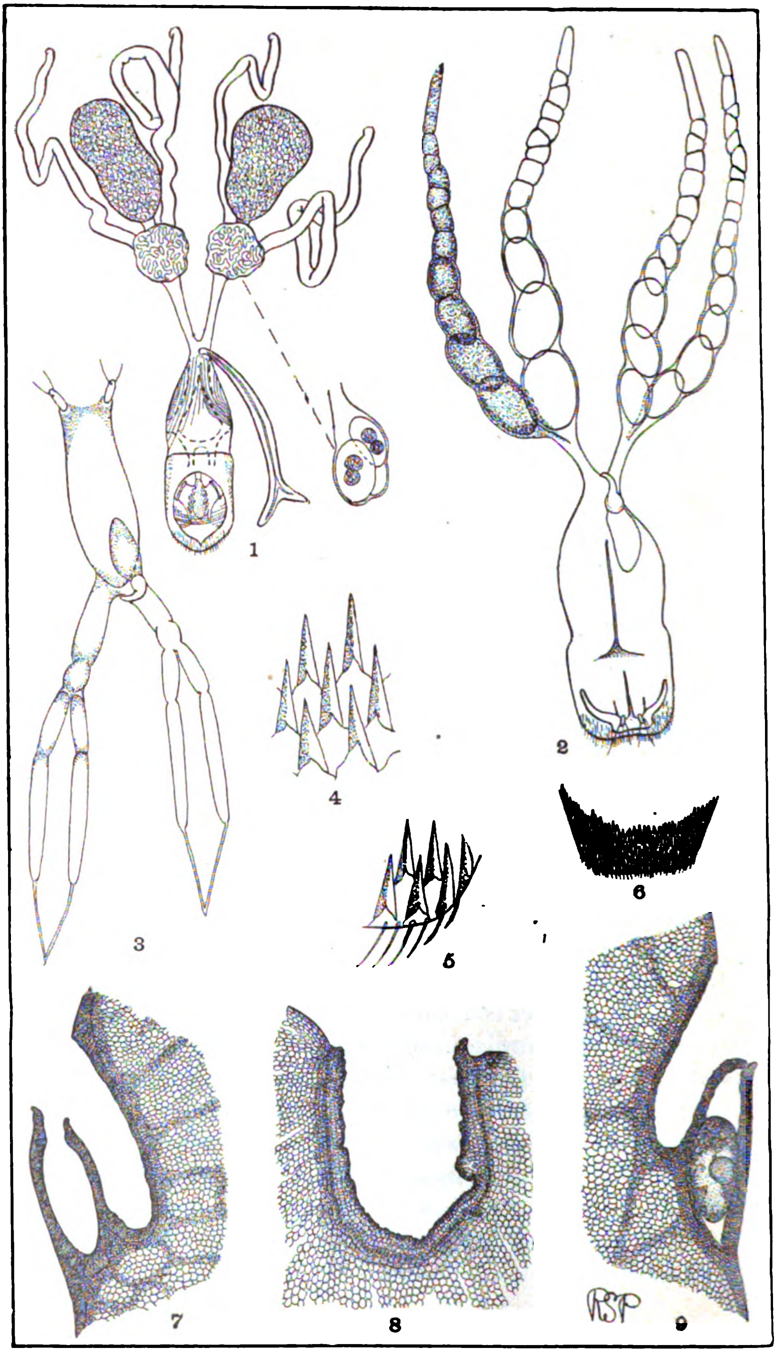

Figure 8.

FIGURE 8.

1. Male reproductive system, much enlarged, showing the genital hook posteriorly, the spermatophores separated.
2. Female reproductive system in process of development, ova partly developed in the tubes and the oviduct developed to its full size: armature of tip partly developed. These individuals have fed and have begun their growth.
3. Female reproductive system not yet developed: ovairum tubes with individual ovaries not separating into eggs. These individuals have just made their appearance on the trees and have begun to feed. The receptaculum seminis is closely applied to the oviduct at the junction of the vagina, and the capsule is clearly made out as it is also on Fig. 2.
4. Flat cutting processes, on the tip of the oviduct, very much enlarged: as they appear on the surface.
5. The cutting processes or teeth as they appear along the edge of the oviduct.
6. Tip of the ovipositor of Plum Curculio showing the recurved teeth under a moderate enlargement. The ovipositor is of full width, but not full length.
7. Incisions made in fruit by Plum Curculio to receive and protect egg. The inner deeper incision is cut with the mouth parts and separates a considerable segment of tissue. The outer excavation has been made with the ovipositor and is just the pressure of that structure close to the skin of the fruit and the withdrawal of the fruit tissue on the flattened teeth—the manner in which the egg is left in the tissue is shown at 9.
8. A normal feeding puncture of a Plum Curculio—in transverse section and much enlarged.
9. Completed egg puncture of Plum Curculio, with egg in position.

May 23d, found 28 beetles on outside rows at High Bridge and only two on inside rows. Out of a dozen selected for dissection, 7 were females, and they averaged a little over 40 eggs approaching maturity.

May 29th, the first systematic count of fallen fruit was made for the season, including 12 Altons, 24 Elbertas and 9 Crawfords. Also two Carmans and two Hileys. With each of the three former varieties—I am now quoting Stafford—three methods of spraying were tried, namely, first, no arsenate of lead in any spray but only the fungicide. Second, one arsenical treatment at time shucks were falling. Third, an arsenical spray in addition to above applied when flower buds were not yet open, or in short two arsenical sprays. The second arsenical spray was applied with self-boiled lime and sulphur. One Carman and one Hiley received only the early arsenical spray. The remaining two received both. Detailed results will be found in the tabular reports of this experiment. Thus far from Mr. Stafford's notes have been given that his tabulated results may have all the light to which his own convictions entitle them.

In the examinations made all the eggs seem to have hatched, and from every hatched egg a curculio gallery developed. Nor does there seem to have been any feeding other than for egg punctures. This does not mean that such conditions did not exist; it simply means that for some reason Mr. Stafford got his counts or material mixed, and that all that can be determined from his data is that during the last days of May and early days of June there was a perfectly enormous lot of drops from the young orchard trees. In fact he has himself summarized the total as over 6,000, and that 2,614 or more of these were clean, free from either curculio or rot. As the season advanced the injuries from the curculios lessened as might have been expected and injury from rot intensified. And while injury from rot and curculio were very generally associated in the beginning, the injury from the rot became more intensified and more aggravated as the season advanced. In any event, there could be no further claim that beetles were not plentiful enough in the orchards, though Elberta, Alton and Crawford in the order named were perhaps the favorites this year. Last year the Carman enjoyed the distinction.

Mr. Blake's Curculio Record on Elbertas.

Plot.	Treatment.	Free.	Slightly Marked.	Badly Marked.
17	Unsprayed	8	28	40
17	Sprayed once	33	37	28
17	Sprayed twice	103	60	55
18	Unsprayed	17	57	60
18	Sprayed once	66	59	39
18	Sprayed twice	120	103	42
19	Unsprayed	1	1	4
19	Sprayed once	16	7	31
19	Sprayed twice	7	5	13
20	Unsprayed	1	4	20*
20	Sprayed once	0	1	5*
20	Sprayed twice	3	2	10*
21	Unsprayed	8	37	56
21	Sprayed once	9	34	20
21	Sprayed twice	5	24	15
22	Unsprayed	0	10	28
22	Sprayed once	18	41	22
22	Sprayed twice	64	80	51
23	Unsprayed	23	83	116
23	Sprayed once	103	186	129
23	Sprayed twice	95	166	84
24	Unsprayed	2	14	34
24	Sprayed once	4	22	36
24	Sprayed twice	11	27	51

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* Part of crop lost.

MR. BLAKE'S RECORDS.

Belle of Georgia.

ORCHARD No. 1.

Sprayed once	Free from Curculio marks	113
	Slightly marked	228
	Badly marked	377
Sprayed twice	Free from Curculio marks	264
	Slightly marked	407
	Badly marked	220

ALL SPRAYS, COLLECTED MAY 29TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
5-4	Crawford	7	3	4	4	4	2	2	2	....	....	4
11-4	"	5	....	5	5	5	2	3	3	....	....	3
17-4	"	4	....	4	4	4	3	1	1	....	....	1
6-5	Elberta	25	10	15	15	15	13	2	2	....	....	2
11-5	"	17	12	5	5	5	3	2	....	2	....	2
17-5	"	53	23	30	29	29	15	14	14	....	1	15
23-5	"	31	18	13	12	12	11	1	1	....	1	2
6-11	"	37	25	12	12	12	9	3	3	....	....	3
11-11	"	16	16	....	....	....	....	....	....	....	....	....
17-11	"	....	....	....	....	....	....	....	....	....	....	....
23-11	"	21	5	16	16	16	8	8	8	....	....	8
6-16	Alton	113	98	15	15	15	12	3	3	....	....	3
11-16	"	74	58	16	15	15	11	4	4	....	1	5
17-16	"	42	42	....	....	....	....	....	....	....	....	....
23-16	"	2	....	2	2	2	2	....	....	....	....	....
	Total	447	310	137	134	134	91	43	41	2	3	48

SPRAYED WITH ARSENATE OF LEAD AND SELF-BOILED, COLLECTED MAY 29TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
4-4	Crawford	2	....	2	2	2	1	1	1	....	....	1
10-4	"	....	....	....	....	....	....	....	....	....	....	....
16-4	"	3	....	3	3	3	2	1	1	....	....	1
4-5	Elberta	44	18	26	26	26	18	8	8	....	....	8
10-5	"	43	11	82	26	26	20	6	4	2	....	6
16-5	"	51	23	28	28	28	7	21	16	5	....	21
22-5	"	48	27	21	21	21	14	7	7	....	....	7
4-11	"	42	12	30	30	30	25	5	5	....	....	5
10-11	"	2	1	1	1	1	1	....	....	....	....	....
16-11	"	1	1	....	....	....	....	....	....	....	....	....
22-11	"	8	....	8	8	8	6	....	2	....	....	2
4-16	Alton	122	82	40	38	38	27	11	9	2	2	13
10-16	"	96	78	18	18	18	11	7	4	3	....	7
16-16	"	28	19	9	9	9	5	4	4	....	....	4
22-16	"	53	18	35	23	23	10	13	13	....	12	25
	Total	543	290	253	233	233	147	84	74	12	14	100

CHECK, COLLECTED MAY 29TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3–4	Crawford	4	......	4	4	4	2	2	2	......	......	2
9–4	"	1	......	1	1	1	1	......	......	......	......	......
15–4	"	......	......	......	......	......	......	......	......	......	......	......
3–5	Elberta	99	38	61	59	59	42	17	17	......	2	19
9–5	"	45	20	25	25	25	15	10	10	......	......	10
15–5	"	61	31	30	30	30	11	19	19	......	......	19
21–5	"	42	27	15	15	15	5	10	10	......	......	10
3–11	"	17	2	15	15	15	11	4	2	2	......	4
9–11	"	17	10	7	7	7	5	2	2	......	......	2
15–11	"	......	......	......	......	......	......	......	......	......	......	......
21–11	"	7	3	4	3	3	2	1	1	......	1	2
3–16	Alton	157	103	54	54	54	47	7	7	......	......	7
9–16	"	33	33	......	......	......	......	......	......	......	......	......
15–16	"	10	10	......	......	......	......	......	......	......	......	......
21–16	"	86	44	42	42	42	29	13	13	......	......	13
	Total	579	321	258	255	255	170	85	83	2	3	88

CHECK, COLLECTED JUNE 5TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3–4	Crawford	16	1	15	15	15	......	9	6	6	......	......	6
9–4	"	9	......	9	9	9	......	5	4	3	1	......	4
15–4	"	2	......	2	2	2	......	2	......	......	......	......	......
3–5	Elberta	131	10	121	119	119	......	79	40	37	3	2	42
9–5	"	94	5	89	81	81	......	61	20	14	6	8	28
15–5	"	127	24	103	91	91	......	84	7	4	3	12	19
21–5	"	154	18	136	119	119	......	96	23	20	3	17	40
3–11	"	64	6	58	56	56	......	34	22	22	......	2	24
9–11	"	67	1	66	63	63	......	54	9	9	......	3	12
15–11	"	30	2	28	28	28	......	26	2	2	......	......	2
21–11	"	23	2	21	19	19	......	17	2	2	......	2	4
3–16	Alton	119	11	108	100	100	......	69	31	19	12	8	39
9–16	"	20	10	10	7	7	......	6	1	1	......	3	4
15–16	"	2	......	2	2	2	......	2	......	......	......	......	......
21–16	"	39	13	26	21	21	......	19	3	3	......	4	7
	Total	897	103	794	732	732	......	563	170	142	28	61	231

SPRAYED WITH ARSENATE OF LEAD AND SELF-BOILED, COLLECTED JUNE 5TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
4-4	Crawford	7	4	3	3	3		2	1	1			1
10-4	"												
16-4	"	1		1	1	1		1					
4-5	Elberta	81	12	69	68	68		58	10	10		1	11
10-5	"	62	5	57	56	56		39	17	15	2	1	18
16-5	"	117	28	89	80	80		69	11	7	4	9	20
22-5	"	76	13	63	55	55		54	1		1	8	9
4-11	"	29	8	6	25	25		22	3	3		1	4
10-11	"	4		4	3	3		3				1	1
16-11	"	1	1										
22-11	"	7	2	5	3	3		3				2	2
4-16	Alton	133	30	103	99	99		95	4	4		4	8
10-16	"	18	8	10	8	8		7	1	1		2	3
16-16	"	21	12	9	9	9		7	2	1	1		2
22-16	"	21	3	18	15	15		14	1	1		3	4
	Total	578	120	457	425	425		374	51	43	8	32	83

ALL SPRAYS, COLLECTED JUNE 5TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
5-4	Crawford	8	1	7	7	7		6	1	1			1
11-4	"	6		6	6	6		5	1		1		1
17-4	"	27		27	27	27		27					
5-4	Elberta	48	4	39	39	39		36	3	3			3
11-5	"	52	5	47	47	47		31	16	10	6		16
17-5	"	168	73	95	82	82		75	7	7		13	20
28-5	"	53	16	37	28	28		25	3	3		9	12
5-11	"	59	44	15	15	15		13	2	2			2
11-11	"	12	8	9	9	9		9					
17-11	"	9	2	7	2	2		2				5	5
28-11	"	19	0	10	7	7		7				3	3
5-16	Alton	80	47	33	31	31		29	2	2		2	4
11-16	"	18	8	10	6	6		5	1	1		4	5
17-16	"	10	3	7	7	7		7					
23-16	"	4	1	3	2	2		2				1	1
	Total	573	212	352	315	315		279	36	29	7	37	73

CHECK, COLLECTED JUNE 12TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3–4	Crawford	......	......	......	......	......	......	......	......	......	......	......	......
9–4	"	5	......	5	5	5	......	5	......	......	......	......	......
15–4	"	......	......	......	......	......	......	......	......	......	......	......	......
3–5	Elberta	55	9	16	36	36	......	30	6	6	......	10	16
9–5	"	32	5	27	25	25	......	23	2	2	......	2	4
15–5	"	60	32	28	9	9	......	8	1	1	......	19	20
21–5	"	47	20	27	12	12	......	9	3	3	......	15	18
3–11	"	26	7	19	17	17	......	14	3	3	......	2	5
9–11	"	31	7	24	17	17	......	17	......	......	......	7	7
15–11	"	2	......	2	2	2	......	2	......	......	......	......	......
21–11	"	11	2	9	3	3	......	3	......	......	......	6	6
3–16	Alton	34	17	17	14	14	......	7	7	2	5	3	10
9–16	"	17	16	1	......	......	......	......	......	......	......	1	1
15–16	"	8	7	1	......	......	......	......	......	......	......	1	1
21–16	"	44	25	19	10	10	......	9	1	1	......	9	10
	Total	372	147	225	150	150	......	127	23	18	5	75	98

ARSENATE OF LEAD WITH SELF-BOILED, COLLECTED JUNE 12TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot. Alone.	Total Rot.
4–4	Crawford	......	......	......	......	......	......	......	......	......	......	......	......
10–4	"	1	1	......	......	......	......	......	......	......	......	......	......
16–4	"	......	......	......	......	......	......	......	......	......	......	......	......
4–5	Elberta	25	4	21	17	17	......	16	1	1	......	4	5
10–5	"	11	3	8	2	2	......	2	......	......	......	6	6
16–5	"	81	59	22	5	5	......	5	......	......	......	17	17
22–5	"	51	25	26	8	8	......	7	1	1	......	18	19
4–11	"	22	7	15	11	11	......	11	......	......	......	4	4
10–11	"	10	6	4	1	1	......	1	......	......	......	3	3
16–11	"	5	3	2	......	......	......	......	......	......	......	2	2
22–11	"	10	8	2	......	......	......	......	......	......	......	2	2
4–16	Alton	27	23	4	2	2	......	2	......	......	......	2	2
10–16	"	30	24	6	4	4	......	4	......	......	......	......	......
16–16	"	9	8	1	......	......	......	......	......	......	......	1	1
22–16	"	18	17	1	......	......	......	......	......	......	......	1	1
	Total	300	188	112	50	50	......	48	2	2	......	60	62

ALL SPRAYS, COLLECTED JUNE 12TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
5–4	Crawford	1	......	1	1	1	......	1	......	......	......	......	......
11–4	"	......	......	......	......	......	......	......	......	......	......	......	......
17–4	"	......	......	......	......	......	......	......	......	......	......	......	......
5–5	Elberta	12	7	5	5	5	......	5	......	......	......	......	......
11–5	"	13	6	7	3	3	......	3	......	......	......	4	4
17–5	"	79	56	23	6	6	......	6	......	......	......	17	17
23–5	"	64	41	23	7	7	......	5	2	2	......	16	18
5–11	"	28	25	3	1	1	......	1	......	......	......	2	2
11–11	"	18	13	5	......	......	......	......	......	......	......	5	5
17–11	"	18	17	1	......	......	......	......	......	......	......	1	1
23–11	"	31	27	4	......	......	......	......	......	......	......	4	4
5–16	Alton	55	51	4	3	3	......	2	1	1	......	1	2
11–16	"	21	21	......	......	......	......	......	......	......	......	......	......
17–16	"	3	3	......	......	......	......	......	......	......	......	......	......
23–16	"	5	4	1	......	......	......	......	......	......	......	1	1
	Total	348	271	77	26	26	......	23	3	3	......	51	54

ALL SPRAYS, COLLECTED JUNE 19TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot. Alone.	Total Rot.
5–4	Crawford	5	3	2	......	......	......	......	......	......	......	2	2
11–4	"	......	......	......	......	......	......	......	......	......	......	......	......
17–4	"	1	1	......	......	......	......	......	......	......	......	......	......
5–5	Elberta	9	6	3	2	......	2	2	......	......	......	1	1
11–5	"	16	9	7	3	......	3	3	......	......	......	4	4
17–5	"	78	52	26	3	......	3	3	......	......	......	23	23
23–5	"	45	21	24	5	......	5	5	......	......	......	19	19
5–11	"	29	23	6	3	......	3	3	......	......	......	3	3
11–11	"	70	54	16	6	1	5	6	......	......	......	10	10
17–11	"	23	14	9	3	......	3	3	......	......	......	6	6
23–11	"	23	12	11	2	......	2	2	......	......	......	9	9
5–16	Alton	16	11	5	1	......	1	1	......	......	......	4	4
11–16	"	9	5	4	......	......	......	......	......	......	......	4	4
17–16	"	5	4	1	......	......	......	......	......	......	......	1	1
23–16	"	1	1	......	......	......	......	......	......	......	......	......	......
	Total	340	226	114	28	1	27	28	......	......	......	86	86

CHECK, COLLECTED JUNE 19TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
8-4	Crawford	......	......	......	......	......	......	......	......	......	......	......	......
9-4	"	......	......	......	......	......	......	......	......	......	......	......	......
15-4	"	1	......	1	1	1	......	1	......	......	......	......	......
8-5	Elberta	21	4	17	12	6	6	8	4	4	......	5	9
9-5	"	8	3	5	4	......	4	......	......	......	......	1	1
15-5	"	20	16	13	5	1	4	5	......	......	......	8	8
21-5	"	11	2	9	6	1	5	6	......	......	......	3	3
8-11	"	1	......	1	1	1	......	1	......	......	......	......	......
9-11	"	11	2	9	6	2	4	6	......	......	......	3	3
15-11	"	6	......	6	4	......	4	3	1	1	......	2	3
21-11	"	8	......	8	6	1	5	6	......	......	......	2	2
3-16	Alton	4	3	1	......	......	......	......	......	......	......	1	1
9-16	"	10	2	8	2	......	2	......	......	......	......	6	6
15-16	"	3	3	......	......	......	......	......	......	......	......	......	......
21-16	"	2	1	1	1	......	1	1	......	......	......	......	......
	Total	115	36	79	48	13	35	37	5	5	......	31	36

ARSENATE OF LEAD WITH SELF-BOILED, COLLECTED JUNE 19TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot. Alone.	Total Rot.
4-4	Crawford	......	......	......	......	......	......	......	......	......	......	......	......
10-4	"	1	1	......	......	......	......	......	......	......	......	......	......
16-4	"	......	......	......	......	......	......	......	......	......	......	......	......
4-5	Elberta	9	6	3	......	......	......	......	......	......	......	3	3
10-5	"	13	5	8	3	1	2	3	......	......	......	5	5
16-5	"	69	53	16	1	1	......	1	......	......	......	15	15
22-5	"	22	12	10	4	1	3	4	......	......	......	6	6
4-11	"	12	7	5	3	2	1	3	......	......	......	2	2
10-11	"	35	20	15	......	......	......	......	......	......	......	15	15
16-11	"	6	5	1	1	1	......	1	......	......	......	......	......
22-11	"	12	8	4	3	......	3	3	......	......	......	1	1
4-16	Alton	18	8	10	2	2	......	......	......	......	......	8	8
10-16	"	17	9	8	2	......	2	2	......	......	......	6	6
16-16	"	11	10	1	......	......	......	......	......	......	......	1	1
22-16	"	7	7	......	......	......	......	......	......	......	......	......	......
	Total	232	151	81	19	8	11	17	......	......	......	62	62

CHECK, COLLECTED JUNE 26TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3–4	Crawford	....	....	....	....	....	....	....	....	....	....	....	....
9–4	"	....	....	....	....	....	....	....	....	....	....	....	....
15–4	"	....	....	....	....	....	....	....	....	....	....	....	....
3–5	Elberta	11	1	10	8	4	4	5	3	....	3	2	5
9–5	"	7	2	5	3	....	3	3	....	....	....	2	2
15–5	"	15	3	12	7	1	6	7	....	....	....	5	5
21–5	"	8	1	7	5	3	5	4	1	....	1	2	3
3–11	"	2	....	2	2	....	2	1	1	....	1	....	1
9–11	"	14	6	8	8	1	7	7	1	....	1	....	1
15–11	"	7	2	5	5	....	5	4	1	....	1	....	1
21–11	"	4	....	4	2	....	2	2	....	....	....	2	2
3–16	Alton	7	2	5	4	3	1	3	1	1	....	1	2
9–16	"	8	4	4	3	3	....	3	....	....	....	1	1
15–16	"	....	....	....	....	....	....	....	....	....	....	....	....
21–16	"	2	....	2	1	....	1	....	1	....	1	1	2
	Total	85	21	64	48	15	36	39	9	1	8	15	25

ARSENATE OF LEAD WITH SELF-BOILED, COLLECTED JUNE 26TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
4–4	Crawford	....	....	....	....	....	....	....	....	....	....	....	....
10–4	"	....	....	....	....	....	....	....	....	....	....	....	....
16–4	"	....	....	....	....	....	....	....	....	....	....	....	....
4–5	Elberta	4	....	4	2	....	2	1	1	1	....	2	3
10–5	"	4	3	1	1	....	1	....	1	....	1	....	1
16–5	"	21	7	14	8	4	4	7	1	1	....	6	7
22–5	"	9	2	7	7	2	5	5	2	1	1	....	2
4–11	"	2	1	1	....	....	....	....	....	....	....	1	1
10–11	"	12	6	6	2	....	2	2	....	....	....	4	4
16–11	"	3	1	2	....	....	....	....	....	....	....	2	2
22–11	"	8	4	4	2	1	1	2	....	....	....	2	2
4–16	Alton	12	5	7	3	3	....	1	2	2	....	4	6
10–16	"	....	....	....	....	....	....	....	....	....	....	....	....
16–16	"	6	1	5	1	1	....	1	....	....	....	4	4
22–16	"	3	3	....	....	....	....	....	....	....	....	....	....
	Total	84	33	51	26	11	15	19	7	5	2	25	32

ALL SPRAYS, COLLECTED JUNE 26TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
5–4	Crawford	......	......	......	......	......	......	......	......	......	......	......	......
11–4	"	2	1	1	1	......	1	......	1	......	1	......	1
17–4	"	1	......	1	1	1	1	1	......	......	......	......	......
5–5	Elberta	35	29	6	......	......	......	......	......	......	......	6	6
11–5	"	9	5	4	......	......	......	......	......	......	......	4	4
17–5	"	25	11	14	5	......	5	5	......	......	......	9	9
23–5	"	17	9	8	7	1	6	6	1	1	......	1	2
6–11	"	13	12	1	1	......	1	1	......	......	......		
11–11	"	33	21	12	1	1	......	1	......	......	......	11	11
17–11	"	15	8	7	2	......	2	2	......	......	......	5	5
23–11	"	13	6	7	5	......	5	3	2	......	2	2	4
6–16	Alton	6	1	5	1	......	1	1	......	......	......	3	3
11–16	"	1	......	1	......	......	......	......	......	......	......	1	1
17–16	"	1	......	1	......	......	......	......	......	......	......	1	1
23–16	"	1	1	......	......	......	......	......	......	......	......	......	......
	Total	172	104	68	14	3	22	20	4	1	3	43	47

CHECK, COLLECTED JULY 10TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3–4	Crawford	......	......	......	......	......	......	......	......	......	......	......	......
9–4	"	......	......	......	......	......	......	......	......	......	......	......	......
15–4	"	1	......	1	1	1	......	......	1	......	1	......	1
8–5	Elberta	2	......	2	1	......	1	1	......	......	......	1	1
9–5	"	......	......	......	......	......	......	......	......	......	......	......	......
15–5	"	3	......	3	1	1	......	1	......	......	......	2	2
21–5	"	1	......	1	1	......	1	1	1	......	1	......	1
3–11	"	......	......	......	......	......	......	......	......	......	......	......	......
9–11	"	1	......	1	1	......	1	......	1	1	......	......	1
15–11	"	......	......	......	......	......	......	......	......	......	......	......	......
21–11	"	1	......	1	......	......	......	......	......	......	......	1	1
3–16	Alton	6	1	5	3	2	1	2	1	......	1	2	3
9–16	"	2	2	......	......	......	......	......	......	......	......	......	......
15–16	"	1	1	......	......	......	......	......	......	......	......	......	......
21–16	"	1	......	1	1	1	1	......	......	......	......	......	......
	Total	19	4	15	9	5	5	5	4	1	3	6	10

ARSENATE OF LEAD WITH SELF-BOILED, COLLECTED JULY 10TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
4–4	Crawford												
10–4	"												
16–4	"												
4–5	Elberta												
10–5	"												
16–5	"	2	1	1								1	1
22–5	"												
4–11	"												
10–11	"	1	1										
16–11	"												
22–11	"												
4–16	Alton	8	4	4	4	4		4					
10–16	"	8	6	2	1		1	1				1	1
16–16	"	4	4										
22–16	"												
	Total	23	16	7	5	4	1	5				2	2

ALL SPRAYS, COLLECTED JULY 10TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
5–4	Crawford												
11–4	"												
17–4	"	1	1									1	1
6–5	Elberta	2	1	1								1	1
11–5	"												
17–5	"	1	1										
23–5	"	1		1	1		1		1		1		1
6–11	"												
11–11	"	2		2	1		1	1				1	1
17–11	"												
28–11	"	1	1										
6–16	Alton	8	3	5	5	5		5					
11–16	"	1		1								1	1
17–16	"	1	1										
23–16	"												
	Total	18	7	11	7	5	2	6	1		1	4	5

CHECK, COLLECTED JULY 24TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
3–5	Elberta	14	1	13	11	....	11	6	5	....	5	2	7
3–11	"	12	2	10	10	....	10	4	6	....	6	....	6
9–5	"	20	....	20	19	....	19	5	14	....	14	1	15
9–11	"	8	1	7	5	....	5	2	3	....	3	2	5
15–5	"	20	....	20	19	....	19	7	12	....	12	1	13
15–11	"	24	5	19	14	....	14	13	1	....	1	5	6
21–5	"	21	1	20	14	....	14	4	10	....	10	6	16
21–11	"	7	....	7	5	....	5	4	1	....	1	2	3
	Total	126	10	116	97	....	97	45	52	....	52	19	71

ARSENATE OF LEAD WITH SELF-BOILED, COLLECTED JULY 24TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
4–5	Elberta	33	1	32	17	....	17	9	8	....	8	15	23
4–11	"	29	8	21	5	1	4	8	1	....	1	16	17
10–5	"	32	4	28	16	....	16	6	10	....	10	12	22
10–11	"	35	11	24	15	....	15	8	7	....	7	9	16
16–5	"	22	3	19	13	....	13	6	7	....	7	6	13
16–11	"	30	5	25	10	....	10	3	7	....	7	15	22
22–5	"	22	1	21	14	....	14	7	7	....	7	7	14
22–11	"	17	5	12	9	....	9	4	5	....	5	3	8
	Total	220	38	182	99	1	98	46	52	....	52	83	135

ALL SPRAYS, COLLECTED JULY 24TH, 1911.

No.	Name.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
6–5	Elberta	6	2	4	3	....	3	3	....	....	3	1	4
6–11	"	25	8	17	4	....	4	3	1	....	1	13	14
11–5	"	9	....	9	5	....	5	3	2	....	2	3	5
11–11	"	49	12	37	19	....	19	14	5	....	5	18	23
17–5	"	17	3	14	12	....	14	6	6	....	6	2	8
17–11	"	38	5	33	24	....	24	19	5	....	5	9	14
23–5	"	4	....	4	4	....	4	1	3	....	3	....	3
23–11	"	9	2	7	3	....	3	3	....	....	....	4	4
	Total	157	32	125	74	....	76	52	22	....	25	50	75

VINELAND TOTALS.

CHECK TREES.

Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
May 29	579	321	258	255	255	....	170	85	83	2	3	88
June 5	897	103	794	732	732	....	563	170	142	28	61	281
June 12	372	147	225	150	150	....	127	23	18	5	75	98
June 19	115	36	79	48	13	35	37	5	5	....	31	36
June 26	85	21	64	48	15	36	39	9	1	8	16	25
July 10	19	4	15	9	5	5	5	4	1	3	6	10
Total	2,067	632	1,435	1,242	1,170	76	941	296	250	46	192	488
Extra Drops	126	10	116	97	....	97	45	52	....	52	19	71
Total	2,193	642	1,551	1,339	1,170	173	986	348	250	98	211	559

ALL THE ORCHARD SPRAYS.

Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
May 29	447	310	137	134	134	....	91	43	41	2	8	48
June 5	568	216	352	305	305	....	279	36	29	7	37	73
June 12	348	271	77	26	26	....	23	3	8	....	51	54
June 19	340	226	114	28	1	27	28	....	....	....	86	86
June 26	172	104	68	14	8	22	20	4	1	8	43	47
July 10	18	7	11	7	5	2	6	1	....	1	4	5
Total	1,893	1,134	759	514	474	51	447	87	74	13	224	313
Extra Drops	157	32	125	74	....	76	52	22	....	25	50	75
Total	2,050	1,166	884	588	474	127	499	109	74	38	274	198

HILEY, SPRAYED ONCE WITH ARSENATE OF LEAD.

No.	Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
26–6	June 6	367	196	171	107	107	....	93	14	14	....	64	78
26–6	June 13	193	158	35	3	3	....	3	....	....	....	32	32
26–6	June 19	132	81	51	19	2	17	17	2	2	....	32	34
26–6	June 27	16	10	6	5	....	5	5	....	....	....	1	1
26–6	July 10	163	74	89	80	....	80	79	1	....	1	9	10
26–6	July 24	18	5	13	5	....	5	1	4	....	4	8	12
	Total ...	889	524	365	219	112	107	198	21	16	5	146	167

HILEY, SPRAYED TWICE WITH ARSENATE OF LEAD.

No.	Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
26–7	June 6	183	88	95	79-	79	....	58	21	21	....	16	37
26–7	June 13	134	115	19	8	8	....	7	1	1	....	11	2
26–7	June 19	60	30	30	5	2	3	5	....	....	....	25	25
26–7	June 27	13	7	6	3	....	3	3	....	....	....	3	3
26–7	July 10	101	39	62	49	5	44	46	3	....	3	13	16
26–7	July 24	42	5	37	15	....	15	1	14	....	14	22	36
	Total ...	533	284	249	159	94	65	120	39	22	17	90	119

CARMEN, SPRAYED TWICE WITH ARSENATE OF LEAD.

No.	Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
25–7	June 6	75	25	50	43	43	....	38	5	5	....	4	9
25–7	June 13	145	126	19	3	3	....	3	....	....	....	16	16
25–7	June 19	64	34	30	13	....	13	13	....	....	....	17	17
25–7	June 27	13	7	6	4	....	4	2	2	....	2	2	4
25–7	July 10	130	47	83	81	....	81	81	....	....	....	2	2
25–7	July 24	1	....	1	1	....	1	1	....	....	....	....	....
	Total ...	428	239	189	145	46	99	138	7	5	2	41	48

CARMEN, SPRAYED ONCE WITH ARSENATE OF LEAD.

No.	Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
25-6	June 6	173	54	119	103	103	....	90	13	12	1	16	29
25-6	June 13	202	159	43	6	6	....	5	1	1	....	37	38
25-6	June 19	111	46	65	29	1	28	29	....	....	....	36	36
25-6	June 27	17	10	7	6	....	6	5	1	....	1	1	2
25-6	July 10	76	21	55	54	....	54	51	3	....	3	1	4
	Total ...	579	290	289	198	110	88	180	18	13	5	91	109

SPRAYED WITH ARSENATE AND SELF-BOILED MIXTURE.

Date.	Drops.	Clean.	Bad.	Total Curculio.	Galleries.	Feeding.	Curculio Alone.	Curculio with Rot.	Curculio Causes Rot.	Rot Independent.	Rot Alone.	Total Rot.
May 29	543	290	221	233	233	....	147	84	74	12	14	100
June 5	578	120	457	425	425	....	374	51	43	8	32	83
June 12	300	188	112	50	50	....	48	2	2	....	60	62
June 19	232	151	81	19	8	11	17	....	....	....	62	62
June 26	84	33	51	26	11	15	19	7	5	2	25	32
July 10	23	16	7	5	4	1	5	....	....	....	2	2
Total	1,760	798	929	758	731	27	610	144	124	22	195	341
Extra Drops	220	38	182	99	1	98	46	52	....	52	83	135
Total	1,980	836	1,111	857	732	125	656	196	124	74	278	476

NOTE.—All drops were thought to be over, when an extreme drought caused a number of Elbertas in our experiment to drop. These are therefore added here to complete the results.

It might seem that after a season of observational and experimental failure the outcome of definite knowledge relating to destructive and remedial measures must be correspondingly small. But that does not really follow. The observations made, were definite enough, even though some of the factors were unintended or unexpected, and there were additional applications and observations made in other orchards that help out very materially the recorded mess. The applications recorded by Mr. Blake and his assistants in the orchards in his charge at Vineland, New Brunswick and High Bridge, have all been taken into consideration and the observations made by Mr. Dickerson, Mr. Weiss and myself, chiefly during the early part of the season in the commercial peach and other orchards, all have been drawn upon in deciding upon the recommendations to be made.

Speaking, primarily, to peach growers, they have, in the State of New Jersey the easiest task of all horticulturists as against the Plum Curculio, provided they will recognize their obligation to maintain a modern orchard so far as planting, treatment and general handling is concerned. Larvæ do not develop well in peaches, nor do they come to maturity at all freely under the normal conditions of a cultivated orchard. It would be too much to say that no larvæ develop in such an orchard—it is fair to say that there are very few that do so. The heavy end of the infestation comes into the peach orchard from the outside, early in the season, and hungry for feeding supply.

Observation has shown quite a little seasonal difference in the appearance of the insects; but, ordinarily, the feeding beetles begin to appear when the blossoms begin to open, and a thorough dose of arsenate of lead just then should get those early feeders before copulation and before sexual maturity. Weather conditions should determine whether a week or ten-day limit should be fixed for the second spraying; but I should put it a week under normal circumstances and might add a fungicide if I were fighting early rot. The later sprayings in a peach orchard have usually the plant disease end in view, but I should recommend the continued addition of arsenate of lead so long as active feeding is observed by the curculio. I should not attempt to reach the abnormal feedings of the exceptional examples of the second brood.

The chief points to be kept in mind in the summer treatment of a peach orchard is to keep the surface as clean and dry as possible and the trees themselves free from unnecessary loose bark, moss or other shelter. It does not seem to be necessary to gather up and destroy the early drops at any time, and only in a wet season would it prove desirable to do anything with the larger later drops. Then they certainly should *not be* cultivated under. They should either be raked up and destroyed or they should be exposed to the full action of the hot sun so as to get a toughening of the fruit.

In the plum and cherry orchard matters are much more serious. There is no doubt that the insect gets in here earlier, no doubt that the larva hatches and develops in the growing fruit, and no doubt either that it is able to reach so advanced a stage in the fruit that it is ready to enter from the decaying mess directly into the moistened soil beneath.

There is much difference between cherry varieties as to susceptibility to curculio attack. I have two trees of early Richmond which almost never have a curculio, but one tree of another variety is badly attacked.

So there is considerable difference between plums, but the differences have not forced themselves upon me, and I would not, from my own observations, recommend any differences between plum varieties.

Jarring is eminently the remedial measure in a plum orchard where it can be promptly and economically carried out. Jarring gets the early beetles and the importance of dealing with these has been sufficiently pointed out. Jarring gets also all the drops, and the importance of getting these and destroying them cannot be over-estimated. I would not allow any plum drop to remain in my orchard over 24 hours after it was more than half grown if I could prevent it, and I would keep a man or boy at work continuously picking them up and destroying them if I had no other way of getting at them.

I should begin arsenical spraying at once as soon as there was a beetle found on the tree, and I should keep the new growth consistently and persistently covered with arsenate of lead so as to kill off as many of the adults as possible. I should use 1 pound of arsenate of lead (Vreeland's Electro) in 20 gallons of water, or its equivalent in other brands at same strength, and I should add ½ a gallon of glucose to part of the water.

In the apple orchard I should fight curculio as hard as anywhere else, and I should expect to get as good although perhaps not as striking reports and results.

Apples, and especially the later varieties, do not show much damage from feeding punctures as a rule, but almost every grower, and certainly every student, has seen the weird cripples that are sometimes produced by excessive feeding.

But there is no doubt that in New Jersey the apple, and especially the more or less neglected apple, has become the nursery for the Plum Curculio, and that the logical point of attack against the latter insect is the apple orchard.

It is in the apple orchard that conditions of temperature and moisture most favor the insect, and it is in the apple that the greatest number of specimens can best come to maturity and develop, and it is in the apple that the insect is able to maintain itself for the longest period of time in the early larval stages. Furthermore, after the apple has dropped to the ground the curculio larva is almost safe, and a dozen or more may develop to full growth within a single fruit in a ferment or decay mixture which does not in any way harm or interfere with it.

The owner of every apple tree and apple orchard owes it to every plum, cherry and peach grower to deal with his apple orchard and trees as against the Plum Curculio, even if he suffers no loss which he traces to it directly; and it will not even be a very expensive proceeding.

Picking up and destroying, *not cultivating,* any dropped fruits is one of the most effective measures in the apple orchard. There is not and cannot be any development in or on the fruit while on the tree, hence there would have to be a period of at least a week in the fruit on the ground before the curculio larva could reach any size, and the collection and destruction of dropped apple fruits in an orchard or under a neglected tree would mean the coincident destruction of thousands of curculio larvæ. The picking up and destroying may be done by men, cattle, sheep or hogs and the only requirement is that it be thorough.

If spraying is to be relied upon, early sprayings with arsenate are necessary, and these will reach as well the bud moth and various leaf-miners as the curculios. The buds on apple come late.

and a large part of the leaf-feeding by the curculio is done on the leaves. To the man who sprays with both insecticides and fungicides to obtain apples which under modern classifications rank first class, we have little more to give as advice. He finds the cleanest kind of clean culture necessary for his results. To the orchardist who has not heretofore realized his duty to his fellow, I suggest that he spray his apple orchard thoroughly as soon as it gets into full leaf with arsenate of lead, 20 per cent. at the rate of 1 pound in 20 gallons of water, or if a lower grade of arsenate of lead is used, with an equivalent strength, and cover as thoroughly as possible.

The second spraying may be that for the Codling Moth, and the third should come in about a week after the second.

After that the looking after the dropped fruits becomes the most important matter and should get the careful attention of the orchardist.

REPORT ON THE MOSQUITO WORK FOR 1911.

REPORT ON THE MOSQUITO WORK FOR 1911.

By John B. Smith, Sc.D.

The Legislature that met in January, 1910, provided in its supplemental bill for ten thousand dollars ($10,000) to become available in April of that year, and for fifteen thousand dollars ($15,000) to become available in its regular bill in November of that year. The Report for 1910 is just off the press in time to give an account of the expenditures made out of that supplemental bill. The report of expenditures made out of the regular bill beginning November 1st, 1911, are shown in the present bill and so are those made out of the supplemental bill beginning May 1st, 1911, and which became available for use about that time from legislation passed during the spring session of 1911.

The annual statement of drained area now is:

	Acres.	Feet of Ditching.
Up to 1907, as reported	15,851	2,215,524
In 1908, as reported	6,669	888,650
In 1909, as reported	2,672	360,800
In 1910, as reported	4,650	350,000
In 1911, as hereafter	8,528	712,000
	38,370	4,528,974

Money available $25,000 00

CONTRACTS.

	Acres.	Feet Ditches.	Contractor.	Cost.	
Fairfield Township	3,000	280,000	Manahan	$7,000	
Berkeley Township	1,728	270,000	Manahan	6,000	
					13,000 00
	4,728	550,000			
					$12,000 00

AGREEMENTS.

Locality.	Contractor.	New Area. Acres.	New. Ditches.	Cost.	
Jersey City	Manahan	....	......	$200	
Elizabeth	Reitter	....	2,000	400	
Maple Island	Manahan	100	4,000	900	
Waverly	Manahan	....	3,000	700	
Kearny	Manahan	300	3,000	600	
Kearny	Manahan	600	1,500	900	
Kearny	Manahan	300	500	600	
Kearny	Dupont Powder Co.	100	......	95	
Brick Tp.	Manahan	800	40,000	935	
Dover Tp., north	Manahan	800	45,000	850	
Dover Tp., south	Manahan	800	40,000	850	
					7,130 00
		3,800	162,000		
					$19,130 00

REPAIR AND CLEANING.

Linden repairs and cleaning	$125 00	
Tremley Points repairs and cleaning	25 00	
Elizabeth cleaning work	300 00	
Elizabethport	40 00	
Manasquan	30 00	
		520 00
		$19,650 00

Appropriation	$25,000 00
Payments in contracts and agreements	19,650 00
Expenses and incidentals	$5,350 00

Under the head of expenses and incidentals come all those outlays for advertising, supervision, traveling expenses and red-tape generally, as well as the salaries for those engaged in the work. At the present time the executive officer and Mr. Herman H. Brehme are the only officers on full pay. Miss Meske is getting nothing for her services specifically on the mosquito work. Mr. Henry H. Brehme is on half pay and helped out by the members of the local boards of health, and Mr. Walter S. Abbott resigned from the office to accept a position with the State Entomologist of Illinois.

There is no doubt that there must be some modification of the work done in the State. It is scientifically correct, or would be if it could be carried out as originally planned. But it did not keep in mind the special needs of cities or towns nor the almost impossibility of moving the average municipal office or officeholder. The usefulness of Mr. Henry H. Brehme to the Extermination League has proved most highly suggestive, and has induced a modification of the character of the report. On the other hand, the original lines on which this work was proposed have justified themselves even more strikingly, and the reports presented by Mr. Henry H. Brehme are most suggestive.

As reports continue to come in from government and other authorities in the tropics it appears that much of our New Jersey information has approved itself elsewhere, and that we have a right to stand by our own conclusions in many instances even when not apparently in line with the original conclusions of the physician, soldier, board of health worker. I was for a time seriously considering the matter of abandoning altogether the fresh water work of the department, and it was really only the realization of how general the two problems are yet united in the Hudson county district that led me to the other extreme of giving more and better help than ever before.

THE CITY, TOWN AND VILLAGE PROBLEM.

The primary object of the State work with mosquitoes in New Jersey is dealing with the migratory or salt marsh mosquitoes that breed in the waste, uninhabited areas near the shore and fly in enormous swarms to cities, towns, villages and other inhabited places, often many miles away. Against these such localities are helpless, and they have a fair claim upon the State to demand that relief which is beyond their own power to afford.

But besides these species there are others, even more annoying, fully as aggressive, actually more dangerous from the sanitary point of view, almost or quite as abundant at many points, which are bred right at home, where they make themselves a nuisance. There is no puddle so small, so well concealed, so dirty, so prominent, that it will not breed mosquitoes of some kind, and some kinds are appropriately known for that reason as "house mosquitoes."

So long as the salt marsh mosquitoes remained dominant, local work would not make much of a show and was not waged nor encouraged by me; indeed one or two abortive campaigns started before this phase of the problem was fully understood, did much to discredit mosquito work in the State; but since these salt marsh forms have been reduced to insignificant factors throughout a large area, the local species have assumed their proper importance. And this importance is really very much greater than was supposed and the problem greater than the local authorities were prepared to meet.

The individual health officers of the municipalities in Hudson, Essex and Union counties soon realized their helplessness, and a Conference Committee on Mosquitoes was organized under the auspices of the Newark board of health. I have on previous occasions found reason to commend the advanced position taken by this board and the aid and facilities that it has given to other boards in their work.

This conference committee accomplished a great deal in spreading information among the boards of health and health officers, and in the years following great progress was made in securing information. But as information was obtained the problem seemed to become ever more formidable, for there seemed to be no end to the places where or conditions under which mosquitoes would breed. Besides, the communities as a rule did not support their health boards properly and some of the health boards did not back up their officers.

Hudson county has a county board of health, and made a progressive step by appointing Mr. William Delaney as mosquito officer for the county at an adequate salary. The Newark board of health appointed an inspector with two permanent assistants and a number of temporary ones to look after the problem within its limits, and other municipalities took more or less half-hearted measures to improve conditions within their limits.

This was helped somewhat by inspections made by my office, and demonstrates that as matters then stood the matter was no longer one for the State, but for each locality.

During the latter part of 1910 the "North Jersey Mosquito Extermination League" with "Headquarters Newark Board of Health Office" came into being. This is "An organization devoted to the extermination of the mosquito on co-operative lines," of which Mr. John W. Dobbins, of Newark, is president; Mr. Joseph F. Lynch, of Harrison, is vice president, and Dr. G. Herbert Taylor, of Maplewood, is secretary and treasurer. Meetings are held on the third Monday of each month and have been well attended during the existence of the organization.

Representatives from Hudson, Bergen, Passaic, Essex, Union and Morris counties are included in the membership, and reports are made every month of progress made.

From the beginning my office has co-operated with this association, and throughout the summer I had in service Mr. Henry H. Brehme, whose duty was to keep continuously under observation the territory covered by the league, to notify the various officials concerned of danger points, and to act in an advisory capacity generally.

First and foremost, to give all the members of the league and the various health officers a basis for their application to their local authorities, I had enlarged maps made of the more dangerous localities, or those containing the more obvious swampy, low, springy or other wet areas that produced mosquitoes, and especially *Anopheles* species in large quantities. All the choked brooks were included in these maps and our field experience for years past was utilized in their preparation. These field maps were turned over to Mr. Herman H. Brehme, my assistant since this work began, and during the winter and very early spring months he went over every foot of ground with the maps, marked out all the known breeding areas and made a concise description of each, together with the means to be taken for temporary improvement and final abatement.

These field maps were reproduced on tracing cloth and duplicated on blue prints, while the reports were duplicated in typewritten copies.

At the league meetings these blue prints and reports were distributed and an effort was made to furnish at least one copy of each to every municipality concerned. Usually the health officer received a copy, sometimes the board as well, and occasionally the mayor manifested sufficient interest to ask for information.

Every municipality therefore started with a stock of local information, and before Mr. Henry H. Brehme went into service on April 1st, 1911, his brother, Mr. Herman H. Brehme, went over the entire territory with him and not only posted him as to the known breeding areas but as to the suspected points to be kept under more or less constant observation.

To estimate the value of this assistance or the results of the work done by the various members of the league in their official positions is almost beyond reasonable possibility. It may seem as if mosquitoes had been as abundant and as annoying as ever during the summer of 1911, but as a matter of fact that was nowhere the case. The flights and swarms of half a dozen years ago are of the past and nothing like it was found anywhere. That there were a great many mosquitoes in some localities, that they were exceedingly annoying, and that they might even be reasonably called a pest in some place is undoubtedly true, and the explanation is clearly enough brought out in the following series of special reports prepared by Mr. Henry H. Brehme for the various localities.

Messrs. Dobbins, Delaney and Richards tell their own story, and I invite especial attention to Mr. Dobbins's story.

We have in the area under consideration one that is fast building up. In which natural drainages are ruthlessly cut without considering results. Areas nearly laid out; some sewered, some with cesspools, some with city water, some with cisterns. New buildings going up with excavations often lying idle for weeks. Factories with receptacles of all kind, necessary and unnecessary, and an unparalleled number of small industries in which water is required, and where stagnant water is accepted as a matter of course. I have been with Mr. Dobbins walking through a city street and had him pause at an open yard door—"Let's step in here for a minute and see what we find"—and have had him point out an old bath-tub set up in one corner with a gallon or two of water and a big brood of wrigglers. This is the city or local problem and that is the particular feature of the problem for which no sufficient appropriation has been made.

North Arlington.

A series of five or six holes along the water main of the Arlington Water Company, which is located north of the Belleville turnpike, opposite the Arlington cemetery. The holes are on property of the water company and should be filled. It would cost only a small sum ($5–$6) to do it and the breeding places would then be permanently done away with.

June 13th, *Culex pipiens* was found breeding there and the health board was notified. June 17th, breeding was again found there in company with Health Officer Edward O'Hara and Dr. J. A. Exton, and they were fully advised as to what should be done. June 23d, breeding went on as before and the Newark men oiled the place to kill off the larvæ.

July 29th, August 26th and September 18th, inspections were made, the breeding places still exist unchanged at the end of the summer and are in exactly the same condition for 1912 that they were for 1911. It cost more to inspect and treat these holes in 1911 than it would have done to fill them!

A breeding pool was found June 13th, on the north side of Belleville turnpike, opposite the Arlington cemetery, about 5,000 square feet in extent. *Pipiens* larvæ were developing in the pool and it was determined that filling would be best here because it was too low to drain into meadow creek. The ownership was in doubt and filling would have cost about $150.

June 17th, showed this place to Dr. Exton and Mr. O'Hara, and told them it should be oiled until filling could be enforced.

June 23d, the Newark city force oiled this pool and killed off the mosquito broods then in it.

July 29th, August 26th and September 18th, inspections were made in this same section. At no time was any work done there by the North Arlington authorities, and at the end of the season the conditions are in exactly the same shape that they were at the beginning.

It is now determined that the property belongs to the cemetery authorities, and the probabilities are that something practical will be done before another season opens.

In the Catholic cemetery, located on the west side of Schuyler avenue, about half a mile north of Belleville turnpike, are several swampy places on which some *pipiens* breeding was found June 17th, and which were pointed out to Dr. Exton and Health Officer O'Hara with the recommendation that the place be drained.

June 23d, the owners had men at work digging ditches and no more breeding was found. Conditions were found good July 29th, August 26th and September 18th, and all these drained places were safe. A brood of *C. sylvestris* was on the wing, but that had come out of the woodland pools formed by the heavy rains early in the month.

Conditions here have been materially improved during the season of 1911. The cemetery authorities have expended about $300, and have given in addition about $200 worth of hay in return for work done.

The Meacham tract is located on the west side of Kearny avenue, about three-quarters of a mile north of Belleville turnpike, and on it I found, June 17th, a dirty swamp 600 x 300 feet, with a good brood of *pipiens,* larvæ and pupæ. It is the largest and worst breeder in North Arlington and I recommended that it be drained and, until then, oiled.

June 23d I found *Anopheles* also breeding on this territory and the Newark city force covered it with oil to kill off the brood. The owners were notified and urged to take action.

July 29th, I found that ditches had been run into the brook to the north and that there had been some recent oiling, so that no breeding was found. So, on August 29th and September 18th. the place was free from breeding and mosquito safe. This area also has been permanently improved during the season of 1911.

Arlington.

April 15th, an inspection in this town located as the principal danger points for *pipiens* the series of pools along the edge of the meadow between the New York and Greenwood Lake railroad and the Arlington cemetery.

This territory should be eventually filled or drained to make it safe, but the authorities were notified that oiling would answer as a makeshift. August 29th, the pools were found oil covered, and during the season they were intermittently treated, but there is no doubt that a great many mosquitoes bred here, and no improvement has been made in the conditions.

Harrison.

Mr. John Lynch is inspector here, and ready enough to do all within his power; unfortunately he gets little backing from his board, and, as a matter of fact, most of the work done in Harrison was done by the employes of the Newark board of health under the direction of Mr. Dobbins.

A nasty place for *pipiens* breeding is a stretch of about 200 feet along the edge of the dumping ground on the south side of Warren street, between Manor avenue and Seventh street. Breeding in great quantity was found here May 3d, June 7th, July 8th, August 8th, 12th, and September 8th—really all season; and so far as I am aware nothing at all was done to check it. The number of specimens bred here for general distribution is beyond estimate.

The so-called Lamp-black swamp is an area of about 150 x 100 feet, used as a dumping ground, and located along the main line of the Pennsylvania railroad, between Fourth street and the Passaic river. This is perhaps the most prolific breeding place in Harrison, and brood after brood came out in almost continuous succession. The Newark authorities put on oil on several occasions and checked the mill for a few days at a time, but it was never more than the most temporary kind of check, and the place is a disgrace to a civilized community.

On grounds of the Worthington Pump Works, between Warren and Sussex streets, is a stretch of about 150 feet, more or less water filled, and in which *pipiens* were found from time to time during the summer. Oil was used at times, and at no period were matters found to be very bad, but the place should be filled and permanently done away with.

Late in the season a surface pool developed on the south side of Sussex street, between Worthington street and Manor avenue, in which a brood of *pipiens* developed. This is a matter for surface grading, and one of those places that becomes dangerous only during a period of heavy rains with a heavy brood of mosquitoes ready to take advantage of every temporary opportunity.

Belleville.

Mr. W. Brand Smith is inspector in this town, and all within his power was done to better conditions.

May 24th, two large *pipiens* breeding ponds were located in Hillside Park. They were pointed out to the owner, taken in hand immediately and eliminated before the end of June.

April 21st, a strip of 200 feet along the River road, facing dump at the foot of Little street, was located as a breeding ground. It was examined again May 11th, 24th, June 27th, July 27th and September 21st, and as a rule was found oiled and comparatively free from wrigglers. There is no doubt that some mosquitoes got out here, however, and, although dumping and filling continued throughout the season, conditions are not much better than they were at the beginning, and the same work must be carried on next season as well.

April 21st, an area of about 20,000 square feet of swamp was located on the east side of River road, and it was advised that this be made safe by draining into the Passaic river at an expense of about $25. Nothing was done, however, and while some of the broods developing here were killed off by oil a very great many mosquitoes bred here and the place is just as bad as ever and will require just as much attention in 1912 as it did in 1911.

There is a swampy area about 150 x 300 feet on the west side of the River road, opposite the old Newark Water Works, which is a bad breeding place, yet cannot be easily dealt with. It is being settled by owners of small plots who are putting in ditches which have no outlets and can have none, and are cultivating the land between for vegetables. Some small houses are also going up and the area is in process of improvement and settlement. The application of oil on these ditches is vigorously resisted by the owners who claim it hurts their crops. There is no sewer, and for the present the place has been left as a breeder.

There is quite a large swampy acreage on property of the East Jersey Water Company, on which both *pipiens* and *Anopheles* breeding were found after midsummer. Some oiling was done and the broods were in part killed off, and a large ditch had been cut, in September, on the southern end of the property, taking off some of the water. Matters will be somewhat better, therefore, in 1912 than they were in 1911.

A pool about 3,000 square feet on the north side of Chestnut street, west of Passaic avenue, bred *pipiens* throughout the season, and after mid-summer *Anopheles* as well. It is formed by surface drainage and should have been graded out of existence. It was merely oiled occasionally and is as bad as ever.

There is a large swamp covering many acres located near the isolation hospital and that undoubtedly breeds the spring species and probably *sylvestris* as well. Its place as a breeder of summer species has not been determined, and, in any case, this is a matter of county ownership and for county action.

In addition, Belleville suffers from the barrel, tub and cesspool nuisance, 16 barrels and tubs being located and dealt with in one afternoon by Mr. Brehme on a house to house inspection with Mr. Smith.

Kearny.

The Kearny problem as based upon the Franck's creek sewer conditions, and the salt marsh locations, are elsewhere fully set out and the experimental and other work is fully detailed. Dr. James A. Exton is health officer and Mr. Albert E. Geissler is inspector, and both of these have co-operated to the extent of their ability in the fresh-water problem—for Kearny has a serious fresh-water problem—as well as in the salt marsh work.

First of all there are numerous catch-basins, cesspools, tubs, barrels and other receptacles throughout the town which demanded attention and received very little, for the most part breeding mosquitoes unrestrictedly throughout the season.

There is a dumping ground along the edge of the meadow, east of Schuyler avenue, north of the Erie railroad, where mosquitoes bred freely throughout the summer. A number of broods were killed off by Mr. Geissler with oil; but at best this was a mitigation only and conditions otherwise are just as bad now as they were at the beginning of the season.

Another dumping ground is located where the Bergen avenue sewer flows into the meadow east of Schuyler avenue, and this is also a perennial breeding place which Mr. Geissler dealt with as best he could from time to time.

Three other dumping grounds are located between Franck's creek and the New York and Greenwood Lake railroad, and these were handled or neglected in the same way.

An ugly place is where the Tappen street sewer comes out into the meadow, and spreads over it because there is no other place to go. Some oil was used here; but the task was so obviously hopeless with the facilities at hand that nothing more than half-hearted work was done.

Another sewerage pool, dependent upon Franck's creek condition, is near the Kearny Gun Club, east of Schuyler avenue, and nothing practical was accomplished here.

West of Kearny avenue, between Bergen and Woodland avenues woodland species were found breeding as early as April 15th, and *sylvestris* bred here throughout the season. Some of them were killed off by oil, but the majority of them carried through.

Breeding pools were located early in the season at Hickory and Pine streets, and the corner of Quincy and Schuyler avenues. These were promptly filled and constitute almost the sum total of permanent work done by the municipality.

At the present time Kearny has the distinction of being by all odds the worst mosquito breeding area for its size, within the limits of northeastern New Jersey, taking in the salt and fresh water species together, and the solution of the problem is in the hands of the municipal authorities—a sanitary problem of the most important character, affecting not only the health of their own but of the neighboring communities.

Bloomfield.

The health inspector of this town is Dr. J. C. Saile, active enough and perfectly competent; but with absolutely no backing in his municipality and working entirely without encouragement.

A great provider is an area 300 x 100 feet south of the Erie railroad and east of Orchard street. It belongs to a florist and could easily be filled at small expense. Brood after brood, literally millions of individuals, developed here, and while Dr. Saile put on oil occasionally, when notified by Mr. Brehme, not much good was accomplished and the breeding place still exists, virulent as ever. This is essentially one of those cases for which the Duffield amendment was prepared.

A swamp in the Brookdale section, 150 x 350 feet, was found breeding both *Anopheles* and *pipiens,* as early as June 2d. Filling began in this area during the latter part of June, and was continued more or less constantly during the summer, so that by the end of the season the breeding area had been much contracted. Some oiling was done also, and a few broods were killed off in this way, but a goodly supply of specimens, nevertheless, emerged here during the season. It is probable that by another year this area will be entirely eliminated.

A large breeding pool is located on the north side of the Erie railroad, about 300 feet east of the Orchard street station. It was kept oiled throughout the season and few if any mosquitoes developed; but it still exists for 1912. Five or six loads of ashes would put it out of existence absolutely and permanently.

Along Second river there is a swampy area that breeds woodland species in spring, and this is now in process of filling. It is not a serious source of trouble in any case.

In the Second river itself, on the north side, at Montgomery and Willet streets, there is a dead, overgrown area in which *Anopheles* and *pipiens* breed merrily and nothing is done to keep the flow of the stream unimpeded during seasons of low water.

Bloomfield is a dirty town as to back yards with numerous barrels and other receptacles as well as worse conditions, and its supply of mosquitoes during the season has been continuous and abundant; enough for its own use, with plenty left over for its neighbors.

Whatever improvements have occurred in the mosquito situation, cannot be fairly charged against the official body that might normally be responsible for them.

Glen Ridge.

Mr. Frederick D. Bell is the active member of this board in mosquito work, and Mr. H. H. Benson is inspector. Both of these gentlemen accompanied Mr. Brehme, April 28th, on a tour of inspection in which a few dangerous places were pointed out, but only one actual breeder, on east side of Ridgewood road, was found.

June 21st, a spring breeding *Anopheles* was located, but no other open breeding place was found during the season, and no breeding was discovered in factories or barrels. The town was kept almost absolutely free from open or visible breeding areas, nevertheless there were mosquitoes enough to be troublesome at all times.

The Kearny salt marsh invasions were, of course, shared with the neighboring municipalities; some of the locals came from the adjacent areas, but perhaps the bulk of the house trouble came from the cesspools which were a great deal more numerous and more dangerous than was appreciated early in the season. Glen Ridge deserves commendation for its work during the summer.

Orange.

Orange, so far as natural conditions is concerned, has few bad breeding places, and Health Officer J. Scott McNutt looked after these, in general, in a satisfactory way. So far as the back yard, sewer basin or housework is concerned, nothing was done in any way by my office.

A small swampy area at the southeast corner of Central avenue and South Jefferson street was found to be a *pipiens* breeding area in early summer, and that was promptly abated by filling.

The Rahway river, on the other hand, was allowed to get into all sorts of bad condition throughout the town, and after midsummer bred *Anopheles* continuously and unchecked. There seems to be some unwritten law that under no circumstances must any one do anything to improve the condition of this unfortunate stream!

South Orange.

The work in South Orange is in charge of Dr. A. C. Benedict, and is perhaps more thoroughly systematized than that in any other neighboring community. Very few natural breeding places remain, and as fast as one is formed or located proceedings are taken to abolish it.

Even the Rahway river receives some attention here, and only in mid-August was a brood of *Anopheles* and *pipiens* located in the village limits.

What may be termed the individual breeding places are the principal sources of trouble here, and in a house to house inspection made by Mr. Henry Brehme with Dr. Benedict, on July 7th, quite a number of tubs, barrels and a breeding cesspool were located, each of them supplying a small vicinage. As one establishment alone furnished 10 breeding tubs, the number of specimens in the supply was not altogether inappreciable.

East Orange.

Dr. R. H. Hunt is health officer here, and gave a demonstration of what could be done with the reasonable backing of the board and a reasonable sum of money to expend. East Orange's record in the past has not been of the best; it would have been hard to better it in 1911.

The brook from Halstead street and Rhode Island avenue flowing southeast and south into the brook that crosses South Orange avenue, in the Vailsburg section of Newark, has always been a bad breeder, and notice of its condition was given May 1st. It was cleaned out for its entire course, kept under observation, and only once during the season, September 19th, were larvæ of any kind observed at any point. While some mosquitoes did undoubtedly escape, the number was insignificant in proportion to what would normally have developed.

Another similar stream coming from Central avenue and flowing south to South Orange and Grand avenue, in the Vailsburg section, was of a similar character, and was treated in the same way. It was thoroughly cleaned late in May, was oiled for its full length on four several occasions, and at no time were wrigglers of any kind found in it during the season.

A little brook flows through a swampy area on the south side of Willcox avenue, opposite Whittlesey avenue, and this was a known danger point. The brook was cleaned out and kept clean, the swampy area was partially filled so that no water lodged during the season, and while it is still a danger area for a wet season it is under easy control and can be completely eliminated without much additional trouble and expense.

A swampy area, 100 x 150 feet, is located on the north side of Elmwood avenue, between Park and Oak streets. Early woodland species were found here May 1st, and *sylvestris* and others occurred from time to time later in the season. Considerable filling was done here during the summer, and the place is in process of improvement. Nevertheless some mosquitoes did get out here during the summer.

Another swampy area about 200 x 150 feet is on the south side of Rhode Island avenue, opposite Elmwood Park, and that required ditching, filling and oiling. *Pipiens* breeding began here in June, and drainage work was also begun at the same time. Breeding continued until late in August, but filling was also started at the western end so that by early September this, the largest and worst breeding area in East Orange, was practically safe. Work must be continued, however, until this area is completely filled or drained, which should be easily accomplished during the winter.

On the southwest corner of Tremont avenue and South Clinton street is a considerable pool which was oiled several times during the season, but which nevertheless bred out several considerable broods of mosquitoes. It requires only three or four loads of dirt to fill it permanently, and why it was left as it was during the summer lacks explanation.

On the south side of Rhode Island avenue, west of where the Rhode Island avenue swamp is being filled in, a large pool was located, September 19th, which contained the largest brood of *pipiens* larva seen in East Orange during the season. The matter was taken in hand at once and oil was applied, and oil must be applied from time to time until this filling is completed, but with ordinary precautions this need not become a danger area.

East Orange has shown what can be done where natural conditions are decidedly bad. She is not freer than her neighbors from back yard and other breeding, and on July 20th Mr. Henry Brehme assisted Dr. Hunt in locating a number of pest holes, notably cellar excavations containing water, of which there seem to be an unusual number in town. On these points, however, I have no further knowledge and no criticisms to offer.

West Orange.

Dr. J. Minor Maghee is health officer here and gets little or no official backing in his fight.

A *pipiens* breeding pool was found as early as June 1st, on the west side of the Valley road, opposite Carey street, and the authorities were advised to either drain into the Rahway river or fill with from seven to eight loads of dirt. Nothing was done throughout the season and up to September 11th, large broods of larvæ were found in the pool and certainly hatched, providing a comfortable fall brood and a hibernating supply.

A dirty brook that comes from Gregory avenue, and flows south into the Rahway river, was noted as early as the end of April and again, as a danger point, June 1st. Nothing was done and by mid-August there was a large brood of *Anopheles* larvæ on deck which also were left to develop unchecked. By September 11th large broods of *Anopheles* and *pipiens* were present, the brook was in as bad or worse condition than ever and the fall and winter supply was provided for.

The Rahway river forms the boundary between West Orange and Orange, and as usual received no attention. Its condition was bad as early as April 22d. Twice attention was called to it in June, and in August it had its brood of *Anopheles* as it had everywhere else, and from then until late in September both *Anopheles* and *pipiens* emerged in any quantity. An interesting feature is that part of this bad breeding area runs right through the public playground and furnishes a little gentle stimulation to the children using it.

Nothing was done by this office in the matter of house to house or individual breeding place inspection.

South Orange Township.

Dr. G. Herbert Taylor is health officer and quite ready and able to do what is necessary, providing he is given the necessary financial and other assistance.

As early as April 5th, Mr. Henry Brehme called attention to the condition of the brook which comes from north of Springfield avenue, and is the line between Irvington and South Orange township. It did not become an actual breeder until early summer when *pipiens* larvæ appeared in it; but from early August, through September, it grew steadily worse, *Anopheles* larvæ being added in ever increasing numbers after the middle of August. If any remedial measures were taken they exercised no appreciable effect so far as Mr. Brehme's inspections showed.

The Rahway river infests this township as well, and the history of the breeding development here is identically the same as that of every other town. It was allowed to become choked. *Anopheles* and other mosquitoes developed almost at will after midsummer, and while there was some attempt to use oil it was only partially effective. These two streams did much to provide the mid-summer and early fall mosquito supply throughout the neighborhood.

Early in June a dirty, wet area of some 500 square feet was located on the Tuscan farm on which *pipiens* larvæ were breeding and continued to breed until after mid-September. Some of the broods were killed off by oil, others got out safely and more time and money was wasted for no permanent result than would have been necessary to fill the place permanently.

Water supply and sewerage in the township is not in good shape and much of the local trouble is due to carelessly kept water barrels, cisterns, cesspools and similar receptacles. Inspections were made August 3d and September 16th, and these points were strikingly brought out. It will require a great deal of patience, education and tact, as well as some expenditure of money, to put conditions here in satisfactory shape.

Irvington.

Mr. Joseph K. Clickenger is health officer and pretty well posted as to the requirements of the mosquito campaign. He did what circumstances and his board permitted him to do; but Mr. Henry Brehme concludes his report on this place with the remark, "In my opinion Irvington did more than its share of mosquito breeding this season." Irvington is especially blessed with both natural and artificial conditions and, while they are entirely within possible control, it requires a united board of health and a reasonable amount of money to make conditions even fairly good.

There is a brook, about 500 feet from the Glorioux factory to Lyons avenue, which was reported as in need of cleaning as early as May 5th. *Pipiens* breeding began there in June, and while some of the broods were killed off by the use of oil, breeding was still going on in September, by which time all attempts to improve matters had been given up.

The line stream between Irvington and South Orange township is over a mile in length and was reported as dangerous, April 8th. *Pipiens* breeding began early, *Anopheles* joined during the first days of August and thereafter until the last September inspection there was no interruption in the performance.

There are a lot of small holes that could have been easily filled on the west side of the Speedway where *pipiens* bred more or less throughout the season. Some of the broods were killed off with oil, but the supervision was intermittent while the breeding was not and a great many mosquitoes escaped.

The Augusta street swamp covers an area of about 150 x 130 feet and bred both *pipiens* and *Anopheles* throughout the season in enormous numbers. The owners made some effort to fill part of this area during the summer; but because some paper or other rubbish was blown into the nearby park, the work was stopped, the authorities preferring to endure the mosquitoes to which they were inured, rather than the offense of flying paper or other rubbish.

In addition, Irvington has an extensive back yard and factory barrel population, which was merely touched upon now and then during the season.

In natural location Irvington has much to commend it; but as a mosquito producer it is still more commendable.

Montclair.

Mr. Chester H. Wells is health officer of this town, is fully competent to deal with the mosquito problem, and has in general the necessary backing. He has not, however, had at all times the needed assistance to enable him to keep up with his work.

June 3d, mosquito breeding was found on the Montclair Park property on a swampy area which cannot be readily drained. At other times during the season larvæ were found, but mostly the place was kept oiled.

Toney's brook flows from the northern part of Montclair, south across Bloomfield avenue. July 13th, there was breeding along its edges; August 7th, large broods of *Anopheles* and *pipiens* were found and the breeding extended from north of the Montclair Water Company to Bloomfield avenue. Several broods got out here during the season.

Nishuane brook is in the southern part of Montclair, and on July 13th the edges were found in very bad condition, with a heavy brood of *pipiens* on deck.

August 7th, another inspection made along the brook showed *Anopheles* and *pipiens* back of a dozen different properties where mosquitoes had been complained of, on Llewellyn road, Orange road, Madison avenue, Draper terrace and Washington avenue. The entire brook was in very bad shape and must have given Montclair a heavy dose of both *Anopheles* and *pipiens*.

July 13th, Mr. Brehme accompanied an assistant on factory and back yard inspections, located eight breeding barrels in one factory and a number of other tubs, barrels, castings, cellars, &c.,

holding water and wrigglers and demonstrating that additional care in looking after local conditions was not undesirable.

On an early inspection in April and May, a number of breeding places for woodland spring species were located, which were in general attended to and had no effect upon the general mosquito supply of the season.

In general, Montclair is very well located and has few bad natural mosquito breeding places, but it is by no means without its problem and is in no position to sit back and criticise its neighbors without first making sure that its own back yards and streams are clean.

Millburn Township.

Dr. Wellington Campbell is health officer here, and Dr. J. Minor Maghee is inspector. Both of these gentlemen are fully impressed with the importance of the work and did what was within their power to improve matters. That they did not succeed is not their fault.

Farley's pond bred mosquitoes throughout the season, all *pipiens* so far as observed, and it is just as bad at the end of the season as at the beginning.

Glorioux's pond, north of the Millburn station of the D., L. & W. railroad, was found to be a breeder of both *Anopheles* and *pipiens*. The pond was really an artificial one, created by damming up a small stream, and the owner removed this dam, restoring the stream. This improved matters at once, confining the water to a narrow, flowing channel and leaving only five small pools on the site of the pond. These pools were oiled during the season and bred no mosquitoes, but they should be filled with a few loads of clean dirt or ashes to get rid of them permanently. The expense would be less than that of oiling for the season.

There is a pond on the east side of Brookside avenue, north of the paper mill, and here *Anopheles* breeding was found after early August around the grassy edges. There are fish in the pond, but the edges are shallow and overgrown and offer ideal conditions for these malaria carriers. It means, of course, the cleaning and deepening of the edges of the ponds so as to permit free access of the fish to the margins at all points. Nothing was done and good fall broods of *Anopheles* got out and are now in hibernation.

The Orange reservoir is on the east side of Brookside drive, about three-quarters of a mile from Millburn Centre, and this is one of the dirtiest breeders in Essex county. *Anopheles* larvæ were found there as early as June 6th, and brood after brood developed until late August. Nothing at all was done here to check breeding, and the supply of malaria carriers developed here is quite sufficient to account for some of the conditions complained of in the region. Most of the water could have been drawn off by a single ditch. The interesting feature is, of course, that it leaves us with a full supply of hibernating *Anopheles* for 1912 and a place for them to get a start on early in the year.

On the property of Mr. Stewart Hartshorne there are numerous woodland pools, breeding early spring mosquitoes only, which would not be mentioned here at all except for the fact that Mr. Hartshorne is spending thousands of dollars eliminating every possible place for mosquito development, and furnishing a refreshing contrast to the general policy of the town.

In addition Millburn has the usual house to house problem to deal with. In one tour of back yards on three streets, fourteen barrels and tubs containing wrigglers were found, and one cellar with water also, containing larvæ and pupæ.

Millburn is beautifully located and should have few mosquitoes, nevertheless it has its problem.

Verona.

The mosquito and sanitary conditions generally, of this place, are looked after by the Montclair health board and, in general, very well looked after. Mosquito inspections were made twice only, April 19th and May 2d, on both occasions for the information of the inspector, to locate woodland breeding places and general danger areas. All the points noted were looked after during the season and presumably kept in good condition. Incidentally, however, it was noted that some breeding of *pipiens* went on in the town gutters, many of which are very poorly constructed, and there is reason to believe that a cesspool population existed in some sections.

Summit.

Mr. Robert N. Hoyt is health officer and perfectly competent to look after the local problem. April 11th, Mr. Henry Brehme went over the ground with Mr. Hoyt, located the woodland pools breeding early species, most of which had been already oiled, and on June 22d, another tour of the town was made, developing nothing new.

Summit, however, has a great many catch-basins and nothing is known to me of their condition, nor was any examination made in back yards or on individual property.

The problem here was almost completely in the hands of the local authorities and I had no complaints.

Roselle.

Roselle and Roselle Park have taken no part in the mosquito work; but both of them have plenty of breeding places that need attention and that is particularly true of Roselle Park, where Mr. Henry Brehme made one inspection in late August. I had found the insects abundant enough before the end of May, and by the end of August, they were breeding in gutters, culverts and ditches throughout the town.

The inspection was made for the information of the local authorities; but so far as I am aware, no action was taken on the report that was made.

Plainfield.

July 11th, Mr. Henry Brehme accompanied the local health officer through the town to locate barrels, catch-basins, cesspools and similar breeding places. The importance of these places is never realized by the local authorities and the number of breeding places discovered is always a surprise. It developed here that while the larger and more conspicuous places were pretty well looked after, the sewer catch-basins were entirely neglected and there was no money to look after the important house to house inspection. In other words, the very species that are most obvious to the householder, are the very ones that are least looked after.

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Hackensack.

The authorities in this city manifested a great deal of interest in the mosquito problem, and I lectured during the winter of 1910–'11 on the general subject of mosquito control. The inspector, Mr. Fritz M. Arnolt, was enthusiastic in the work, and I sent Mr. Herman H. Brehme over the city and its surroundings with him, to point out the danger areas.

June 28th, Mr. Henry Brehme went over the same territory with Mr. Arnolt, and found everything oiled and no breeding going on. On the other hand, the back yards and factories proved veritable mosquito mills, fifty barrels in one factory yard being found swarming with larvæ and pupæ, while smaller numbers were everywhere throughout the city. It seemed to be at all points the most typical case of breeding your own supply in your own premises, with a liberal supply over for general stock and open street.

The slaughter in this city alone, of wrigglers and pupæ, was beyond computation, and much of the relief is permanent.

Hudson County.

It has been several times mentioned that the work in Hudson county is under the supervision of Mr. William Delaney, an appointee of the county board of health. At my request Mr. Delaney submits the following report of his operations in the county, exclusive of the work done on the Kearny meadows, and in the other municipalities and localities that are specifically treated.

Mr. Delaney deserves unlimited credit for what he has succeeded in accomplishing in Hudson county with very little backing from the actual governing bodies. He has secured his help in almost every instance from those directly interested as owners in the territory to be benefited. He writes:

"I have the honor to submit the following report of mosquito work in Hudson county, under the supervision of the county board of health, during the past summer, exclusive of work on the Kearny meadows, a record of which you have.

"The work here, as is the case generally throughout the State, is being prosecuted under very adverse circumstances, owing to a lack of interest on the part of municipal authorities. However, the co-operation of private individuals and corporations has far exceeded any assistance heretofore rendered in scope at least, if not in actual expense, and were it not for such co-operation with the efforts of the county board of health, I should not be able to report very much progress."

A careful inspection of the drained area, as outlined in my last report, was made during July, 1910, and the necessity of about fifteen thousand (15,000) feet of ditches was found. Through your office those ditches were installed during March and April, 1911, completing about fifty (50) miles in the county to the above date, after which I had the entire drained area thoroughly inspected and ditches cleaned where necessary, and it may interest you to know that I found almost all the ditches in perfect shape and efficiently working, even those which were made in 1907. That part of the work completed, I devoted my time to breeding places on private and corporation property, and during the season I have had the pleasure of seeing very many breeding places wiped out of existence.

Of course, I cannot give a detailed account of the assistance received from all interested parties. I desire, however, to give credit where due, and mention a few of those to whom I applied and from whom I received ready and very material assistance.

In July, I found considerable breeding of salt marsh mosquitoes in what is known as the Secaucus meadows, on a part of the meadows east of Penhorn creek, north of the Greenwood Lake branch of the Erie railroad, and south of the Delaware, Lackawanna and Western railroad, owing to the fact that the ditches there did not thoroughly drain the territory. Being without the necessary money to remedy the trouble, I applied to Mr. A. J. Næfie, principal assistant engineer of the D., L. & W., the trouble being adjacent to the Boonton branch of that road. Mr. Næfie very kindly consented to inspect the trouble, and on the 12th of July I had Mr. Næfie's permission to have the necessary work done and charged to the D., L. & W. railroad. I had Mr. Jesse P. Manahan, of Red Bank, do the work, the cost which was two hundred dollars ($200), was paid by the D., L. & W. railroad. In connection with this matter, I desire to say that this company was not in any way obligated to do this work, the trouble was not on the railroad property; but like all other corporations with which I have dealt on matters pertaining to the work, they were ready and willing to do more than their share.

The Central Railroad of New Jersey have used oil on all breeding places on their property which have not been filled in.

The Hudson County Park Commission have taken care of all their property by the use of oil.

The Jersey City Shade Tree Commission, who have charge of city parks here, very willingly complied with my suggestion and have done about all that was done in Jersey City to prevent the breeding of *pipiens,* the city board of health having done absolutely nothing.

However, I believe the people generally are becoming more impressed with the idea that the mosquito pest can be abolished, and that the time is not far distant when this work will receive the support of municipal governing bodies and the encouragement of the people generally. I draw these conclusions from the fact that when people who are in a position to help are convinced that the thing can be done, they are willing to render assistance.

The Public Service Corporation, owners of considerable real estate in the county, are among those who deserve special mention, from the fact that they have readily assisted since the work was under the supervision of the county board of health. During the past summer they have continually cared for breeding places on their property, by the use of oil. In July last I arranged with Mr. Osgood, of the Public Service Corporation, the preliminaries of a contract which is now being fulfilled, by which they are having filled in all breeding places on the real estate holdings in and surrounding Jersey City, at an expense of six hundred dollars ($600).

The county park commissioners, whose meadow property extends from the West Side Park, Jersey City, to the Hackensack river, in area twenty-five hundred by fourteen hundred feet (2,500′ x 1,400′), and upon which some *sollicitans* and *cantator* were bred during the past season, are now arranging to *thoroughly* drain this area, which will eliminate that as a breeding ground.

On county property at Snake Hill I found considerable breeding during the past summer, and owing to the fact that the new Pennsylvania electric railroad separated this property from the Hackensack river, I found this a rather difficult and expensive proposition to drain. However, after several conferences with the county freeholders and Mr. C. S. Krick, superintendent, and Mr. Harris, division engineer of the Pennsylvania railroad, I have undertaken a system of drainage which necessitates cutting through two embankments, one, two hundred feet (200′) wide and the other, two hundred and fifty feet (250′) wide, and varying from three (3′) to eleven (11′) feet deep, in order to draw stagnant water to railroad culverts and through them into the river. This work has been in course of progress since October 12th and will be completed about November 15th, costing in the neighborhood of seven hundred dollars ($700), the Pennsylvania Railroad Company defraying one-half cost and the county board of freeholders one-half.

Including the work done in the township of Kearny, the expense of which was defrayed by your office, I conclude that about forty-two hundred dollars ($4,200) worth of ditching and filling in was done in this county under my supervision since March last. This amount, of course, does not include money expended for oil and labor in treating breeding places in the county.

During the season just closed the mosquito pest was quite troublesome in Hudson county owing to the fact that, as above mentioned, municipal authorities entirely neglected such breeding places as sewer catch-basins, resulting in an abundance of *pipiens*. I am satisfied, however, that this county was never so free of the salt marsh mosquito as during the past year, which I think the reports of your inspectors will verify.

Secaucus.

Conditions on the Secaucus meadow have been good throughout the season in a general sort of a way. Several inspections have been made from time to time, the usual monthly inspection for the benefit of the Mosquito League, and several others at the request of Mr. Delaney.

At the time that the meadow in this section was originally drained it was a small triangular piece of salt marsh cut off by an embankment of the Pennsylvania railroad, taking in a portion of the Isolation Hospital, and leaving a small swampy area without outlet of any kind except over a solid right of way. This area was carefully examined by Prof. Smith and myself, and Prof. Smith decided that, left as it was, it would change its character from salt marsh to a fresh water cat-tail area in the course of a year or two and become harmless as a mosquito breeder. A conclusion with which I agreed.

During the summer of 1911 Mr. Delaney found a very large number of mosquitoes in this area, many of them salt marsh species, but the adults only, and no evidence that the insects actually bred there. The territory while not really a mosquito breeder at this time unquestionably does harbor mosquitoes, and Mr. Delaney succeeded in interesting the railroad in its removal. There is a culvert through the embankment of the Pennsylvania railroad some distance up the marsh, which leads into Penhorn creek, but to reach this culvert it will be necessary to dig through a ridge of highland and to make a permanent trench through solid ground, and afterward to carry a wooden trunk through a mass of semi-liquid mud in order to hold open a drain that will carry off the water through the culvert into Penhorn creek. It can be done, however, at a cost of about six hundred dollars, and it will undoubtedly facilitate the drying off of this triangle.

The rest of the Secaucus territory was State ditching work, which maintained itself during the season with practically no attention, and no adverse conditions developed here. It was a case of work properly done in the first place, which simply needed looking after to prevent interference.

Vailsburgh.

This is really to be treated as a section of Newark and was dealt with as such throughout the season by Mr. Dobbins. The brooks and swampy areas here were found in bad condition early in the season, and all the brooks were improved by cleaning or improving in flow. A great deal of oil was used and was necessary because brood after brood developed at one point or another. At the end of the season matters had improved somewhat and the area is in better condition than it was a year ago. It is one of those places that Mr. Dobbins can himself tell about.

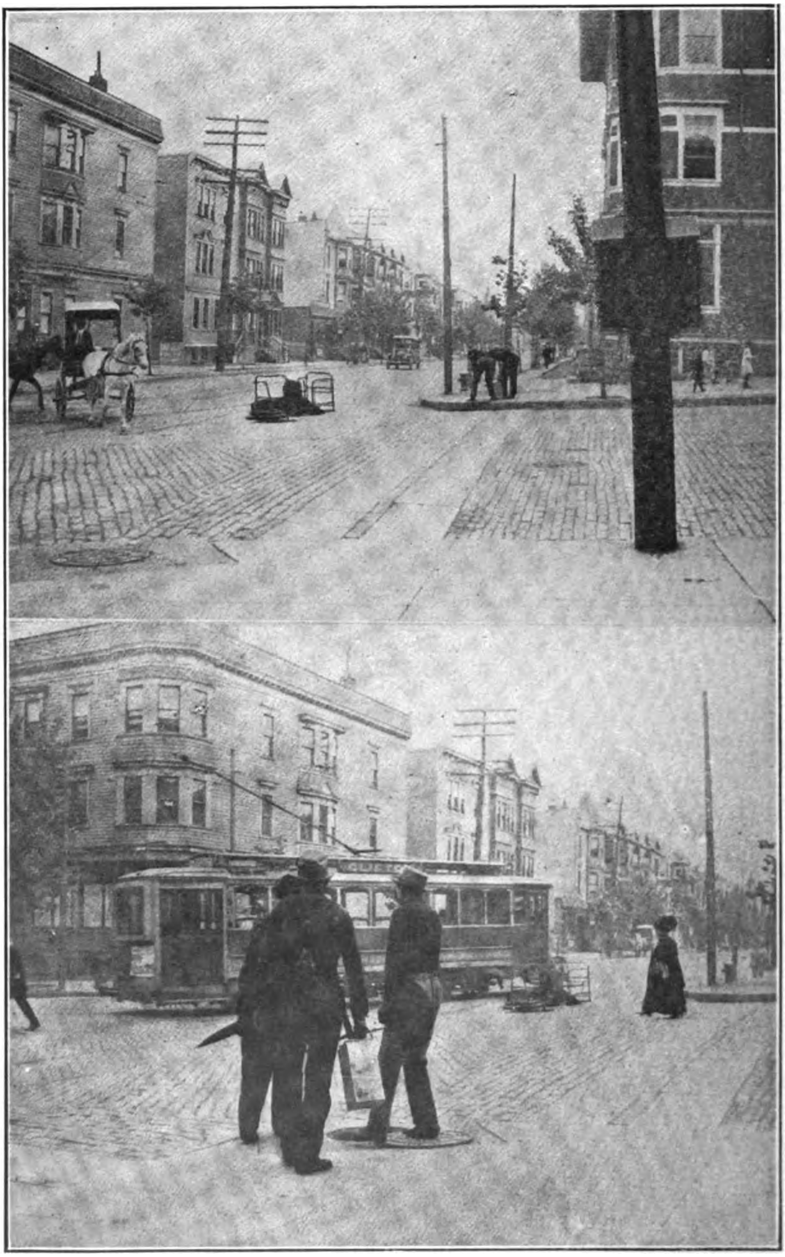

Figure 1.

Street scenes in Newark, showing catch basins ready to be oiled.

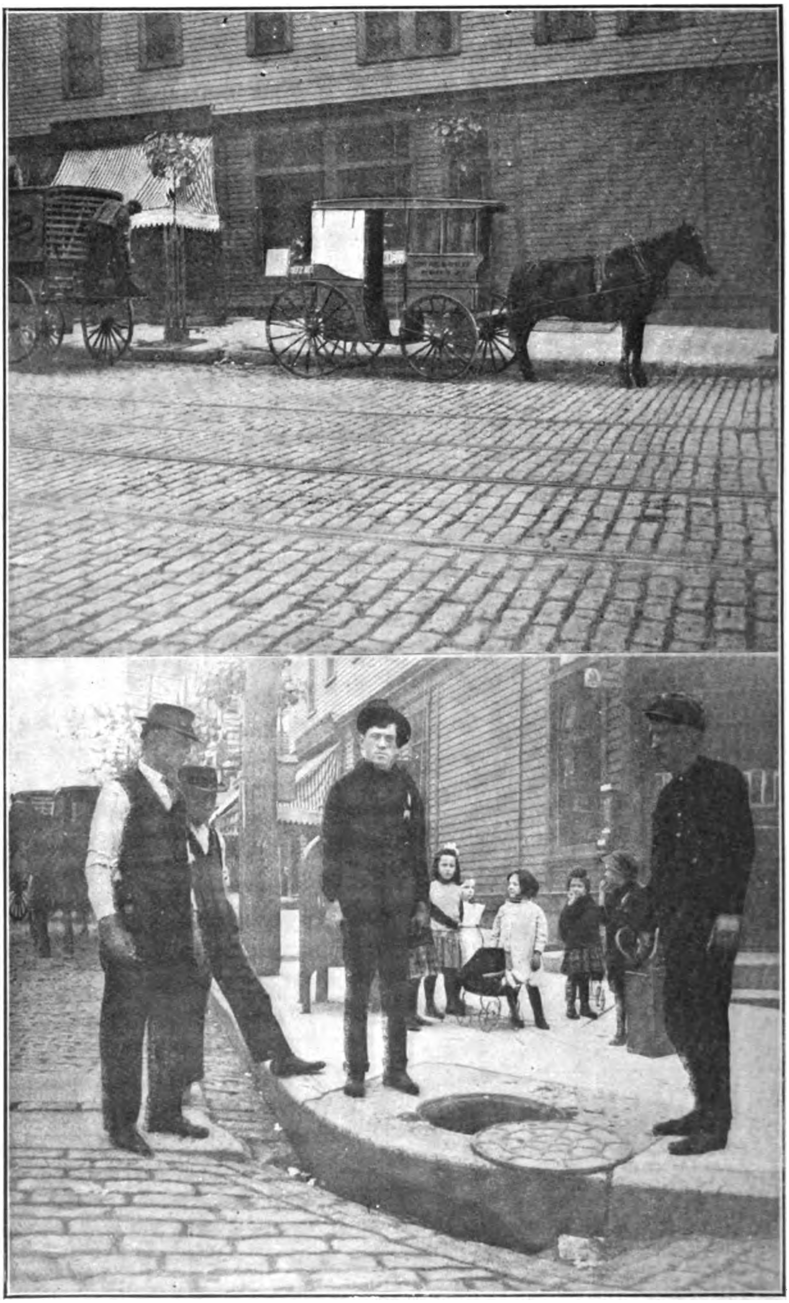

Figure 2.

Street scenes in Newark; getting ready to oil catch basins.

Waverly.

This also is really a section of Newark and was under the general charge of Mr. Dobbins's men. There were two swampy areas of considerable extent on the west side of Frelinghuysen avenue and on the south side of Evergreen avenue, and these were dirty *pipiens* breeders as early as May. They were oiled again and again and very few insects got out, but no improvement was made in the character of the place and it is as virulent a breeder now at the end of the season as it was at the beginning. The places must be filled to be cured.

There are two brooks east of Frelinghuysen avenue, one of them south of Evergreen avenue, the other north of McClellan street. They were both breeding *pipiens* in May and throughout the season, and both were oiled again and again, millions of larvæ being killed off. Nothing else was done to the first mentioned of the two brooks and no doubt a goodly number of mosquitoes escaped the oil. The other brook was cleaned for a distance of about one hundred feet, given a better flow and no doubt kept under better control, fewer specimens issuing during the season.

Newark.

This record, as indicated, is practically as handed in by Mr. Dobbins. There have been some necessary changes in the reference to the salt marsh work to make it accord in general with the account given elsewhere of the work on this territory, and it has been deemed well to bring the general account of the work in the city in line with the accounts given in the other places.

Mr. Dobbins writes: While we have been fighting mosquitoes here for the past seven years, this is really the first year that the work has been done along systematic lines, and the amount of work which had to be done at the start was so enormous and so unexpected that we could not prevent great numbers of mosquitoes from reaching the winged stage.

On March 1st we started work on the salt meadows. Many of the ditches had not been systematically nor thoroughly cleaned since they were first cut, and, as a result, whereas they were originally about twenty-four inches deep, the sedimentation of years had filled them in some instances so completely that it was found desirable to recut rather than to clean. With a force of fourteen men we worked on the meadows until May 10th and then took up the city fight against *Culex pipiens*. When the work was stopped on the meadows much still remained to be done, and it will take another year before we have the area as thoroughly cleaned as is desirable. We are now working on the meadows this fall, continuing the work where it was left off in spring, and will continue until freezing. All pools will be connected up to the ditches directly, so as to avoid breeding conditions caused by continued east winds, rains, full moons and high tides, and I feel certain that so far as Newark is concerned, we will breed very few marsh mosquitoes next summer, provided we can complete what work we have to do before breeding time next spring.

I took up the work with the fresh water mosquitoes early, so as to be in a position to thoroughly study this phase of the work and not to be caught unprepared. I started with two wagons, oiling the catch-basins even before there was any indication of breeding in them to make sure that no mosquitoes came from them during the summer. I so arranged this work that each basin received a coat of oil once in fifteen days, and, profiting by past mistakes, the oil was sprayed in the basin only after the top lid had been removed, so that the man doing the oiling had a clear view of the entire interior of the basin and could see that every part of the water was covered. I consider this part of the work a thorough success, and am sure no mosquitoes came from the sewer basins during the past summer.

We also kept all standing rain water collections under close observation and covered them with oil whenever necessary, and this work was done so persistently that I am sure no breeding occurred in these places. The great hordes of larvæ that we killed off in these pools during the past summer cannot be estimated in numbers.

The several brooks which run through the city were watched closely, and so far as that part of them that traverses the Newark city limits is concerned, very little breeding took place in them and very few adults matured. We were very liberal with our applications of oil and saw these brooks at frequent intervals.

Now, to those not thoroughly familiar with the work, it would seem that this would be sufficient to warrant a great reduction in mosquitoes, but such is not the case. When, after all the work we had done, the fresh water mosquitoes became prevalent in large numbers, but not by any means as prevalent as in former years, there could be but one conclusion, and that was the necessity for a house to house inspection of the entire city. This was a large proposition for my limited force of three men, myself included; but to satisfy my curiosity I started this sort of an investigation, and it revealed a condition beyond all expectation. For instance, in the tannery of Henry Lang & Co. I found twenty odd vats in an abandoned beam house. The vats had not been used for two years, and each vat contained a large quantity of water swarming with wrigglers. In the storage yard of the Hedden Construction Company we found forty-four barrels containing water in which mosquitoes were breeding in enormous quantities.

We have found to date—and the work has covered less than half the city—more than eight hundred barrels breeding mosquitoes, forty-six cisterns used for no purpose except to breed mosquitoes, since city water has been installed, about seventy-five abandoned wells, and every tannery building breeds mosquitoes in all the vats not in use, and which are kept full of water to keep them "tight." Of course, this accounts for the swarms of house mosquitoes that are so generally distributed throughout the city.

I have succeeded in having several bad pools filled in and have pictures of such places showing the conditions before and after filling. The Lehigh Valley Railroad Company on my recommendation has filled in several places at considerable expense, one in particular being the worst place I had in the city, about two hundred feet long and twenty feet wide, in the Hamburg Place freight yard.

During the winter months I expect to have several bad places filled in with garbage and then to have a layer of clean earth over it before spring.

We have learned a great deal more of the problem this year, and it has brought clearly to my mind the importance of a house to house inspection.

It would surprise you to see the number of barrels found in the yards of German people, who have a little garden and use barrels to catch the rain water to put on the flowers and truck in dry seasons. The Italians are great drinkers of home-made wine. In summer they put the barrels from which the wine has been consumed into the yard, partially fill them with water to keep them tight until the grapes are ripe and the wine-making time arrives.

Just think, in the yard of one of the city's wealthiest residents on Mt. Prospect avenue, we found thirteen sewer catch-basins all hatching out one brood after another of mosquitoes! In the blacksmith shop of J. N. Quimby & Co. we found them breeding in the tubs alongside the unused forges, while in a factory making hat machinery we found them breeding in the machines. There is a box on each of these machines to "douce" the hat form in. Several of these new machines were on the floor and all breeding *pipiens*.

I hope to start the house to house inspection early next year by dividing the city into districts and placing an inspector in each district. I have carefully noted conditions this year and have listed every place where breeding has been found, and next summer the inspector will see these places at stated intervals.

We do not urge upon the people to get rid of a barrel when we find it, for they may sell, and then we would probably have to hunt for it all over again. We simply tell them how to keep it and then go back from time to time and watch it.

Lyons Farms.

The authorities of this place do nothing; both Mr. Dobbins, of Newark, and Mr. Richards, of Elizabeth, keep it under observation, and Mr. Henry Brehme made several inspections during the season. There are several swampy areas of considerable extent in which *sylvestris* and woodland species breed from time to time, and these should be drained as they easily can be.

The worst of these areas, because it breeds both *Anopheles* and *pipiens* as well, is located south of the Irvington branch of the Lehigh Valley railroad and the Glorioux plant. This was oiled once during the season by the Elizabeth force. It can be drained, without much cost or trouble, into the brook, and until that is done it will be a source of danger to North Elizabeth as well as its own immediate surroundings.

A more temporary danger area of about 150 x 100 feet is on the north side of the Lehigh Valley railroad, opposite the West Elizabeth station. This fills in long rainy spells or in heavy downpours, and produced only one huge brood of *pipiens* which Mr. Richards succeeded in killing off before it got on the wing.

to these rather extensive areas which make Lyons Farms a source of danger to its immediate surroundings, it has a supply of cesspools and other sewage conditions which give it a local supply of considerable extent, against which nothing whatever was done by local forces.

Elizabeth.

The following report was furnished by Mr. Louis J. Richards, the health officer of the city of Elizabeth, at my request.

INSPECTIONS.

These were started on January 6th, and two inspectors and the writer made frequent inspection from that date until the first of October in watching conditions, discovering breeding places and notifying owners of pools. A house to house inspection was made in June of all the section north of the Central railroad from the Elizabeth river to Madison avenue, as in this and the two previous years *pipiens* were more numerous in this section than in any other part of the city. There are fewer rain water cisterns, outhouses or low lots incapable of drainage in this section, and it should be the freest from house mosquitoes. With the exception of a few manure barrels, barrels of water for watering gardens, and a few smaller receptacles, very little breeding was found, and the conclusion was reached that the number of mosquitoes was entirely out of proportion to the few breeding places discovered, and must have been due to a flight from a considerable distance, in some cases well over a mile. While this is being written Mr. Henry Brehme, of your office, is making a thorough inspection of the adjoining districts in Union county bordering on this and on the northwestern section of this city, with a view of determining and locating sources of probable breeding, so that interest may be aroused and action taken before the spring breeding season begins in 1912.

In addition from April to the 1st of October, both Mr. Herman H. Brehme made frequent inspections of the salt meadow, and Mr. Henry Brehme of the upland area, reporting any mosquito breeding found, which was always promptly attended to and the spots drained or oiled.

CELLAR FUMIGATIONS.

These were started on March 18th, and from that date until the end of April, 54 cellars were fumigated to destroy hibernating mosquitoes. The mode employed was with Mim's Culicide, at the flat rate of $1.50 per cellar, irrespective of size, as recommended at the February meeting of the North Jersey Mosquito Extermination League. As cellars varied from 8,000 to 30,000 cubic feet in contents, and as the charge, if labor is included, did not cover the expense, I should suggest that, unless the work is done gratuitously, the charge be not less than 15c. per 1,000 cubic feet, which would just about cover all costs when supplies are obtained at the wholesale rates. As the State law only prohibits the harboring of larvæ and not adult mosquitoes, it is doubtful if the owner or occupant of any premises could be compelled to get rid of hibernating mosquitoes; but public sentiment demands that nothing be left undone to eliminate or lessen the pest, consequently it will be for some years to come a portion of a health department's work to fumigate cellars. This being so, it is proposed to recommend an early response to the notification, so that the work can be finished so far as possible before the end of March, when attention can better be turned to outdoor work.

The following is a table of costs, with the exception that labor is only charged for seven days' time in which 21 fumigations were done. The remainder was done by inspectors of the board, as the man who was hired for this purpose became ill and a suitable substitute could not be found.

STATEMENT—CELLAR FUMIGATIONS FOR MOSQUITOES.

Labor—	7 days, at $2.00	$14 00	
	Car fare	1 40	
			$15 40
Culicide—	25 lbs. Camphor, at 48c	$12 00	
	25 " Carbolic. " 13c	7 28	
	20 " Camphor, " 50c	10 00	
	10 " " " 50c	5 00	
	10 " " " 50c	5 00	
	10 " Carbolic, " 15c	1 50	
			40 78

Alcohol—			3 15
Apparatus—	Alcohol lamps, &c.	$8 80	
	Generators, 12 at 35c	4 20	
	Tins, &c.	72	
			13 72
	Total expenses		$73 05
Receipts—	Fumigations. 54 at $1.50		81 00
	Balance to City Treasurer		$7 95

PREPARATORY WORK.

This was started on January 9th, and up to February 3d, 36 days' time were used in cutting brush several thousand feet along an old water course leading from Old Port avenue, near Division street, to the outlet of the Fairmount avenue sewer, and thence to Woodruff's creek on the salt marsh. Along Henry street, north of Olive street, numerous pools were then cleared of heavy brush which could be done only when the ground was frozen, and which would permit the oil to reach all parts of the surface. This section of the city comprising the upland north of the Central railroad and east of Henry street, is often called "The Bush," and certainly it is well named, for a more compact second growth of oak and other trees entwined with briars and vines would be hard to find. Some of the pools occurring here can be drained into the outlet ditch, but others had to be cleared for treatment.

In addition, the stock of tools was looked over and needed new supplies obtained.

Great ditch, the outlet for a large section of our salt marsh, was cleared of stones on March 23d, which were placed there in the winter by boys.

DRAINAGE—INLAND.

This was started March 16th, and continued to the end of May, with some interruptions when the men (from two to eight in number) engaged in this work were shifted to the meadows to oil or to help out the regular gang upon particularly favorable days when the tide was low or conditions required their services. The total amount of labor used for this work was 125 days.

The ditch leading from Old Port avenue, near Division street, to Woodruff's creek, which had already been cleared of brush early in the season, was cleaned out, removing all pockets formed by obstructions in the old ditch and draining a large area of swampy brush land, and also a pond of several acres in extent which apparently had a few larvæ along the brushy and overgrown ditches, but where thousands were found as the water receded and they could be observed as they floated down the ditch or collected in the small muddy pools left. This was an admirable example of a pond overgrown with a mass of water brush and grass which concealed most of the larvæ present. It was impossible to oil even the ditches of this pond before drainage, which was fortunately completed by the middle of April in time to cut off the first brood.

The following old drainage ditches were also cleaned:

Along Fay avenue, on the west side of the Pennsylvania railroad, from Bayway to the city line.

Along New York avenue, on the east side of the Pennsylvania railroad, from Bayway to the city line.

West of Grove street, near Murray, in Fay's woods.

On Westfield avenue, east of Grove street. (This property has since been filled in.)

On West Grand street, east of Grove street.

On the west side of the Pennsylvania railroad from North avenue to the Waverly line.

On Sheridan avenue, from Wilder street to the Waverly line.

In addition, the Elizabeth river was cleaned from Parker road to Bridge street.

On June 20th the first flight of *pipiens* was noticed, and complaints were received from the north and northwestern parts of the city. Since then, up to the first of September, notwithstanding our best efforts, *pipiens* have been abundant and a pest in these sections of the city. After the first part of September they gradually disappeared.

DRAINAGE—SALT MARSH.

The work on the meadows began on April 4th and continued until May 23d, with a force of men varied from 15 to 20. After this date two men were kept on the meadow until the middle of June, by which time our funds were exhausted and all salt meadow work with the exception of some oiling (described below) was stopped. Our first drainage on the meadows was done in 1902 and continued during 1903, 1905, 1906 and 1907, by which time the total meadow had been drained. In the fall and early winter of 1908 Great ditch was widened and deepened, and Woodruff's creek and other large drainage outlets were cleaned. In 1909 and 1910 the greater part of the small drainage ditches had been gone over, but this was the first year that all the ditches on the west and south meadows were all cleaned out in one season.

The first brood of salt marsh mosquitoes noticed by me on our meadows was hatched around Bay pond on May 7th. The cleaning of the ditches had proceeded almost to this point at that time, consequently the flight was small and very few reached the city. From the 30th of May to the 13th of June it rained almost continuously, as almost six inches of rain fell. On June 9th the salt marsh species were quite abundant in the city, but after the rainfall, ending on the 13th, ceased, the salt marsh mosquito disappeared, and from that time on we have had no trouble from them this season, except during the first ten days of September a small brood was noticed.

OILING.

That portion of our salt marsh adjacent to the south and southeast edge of Great Island is low and a considerable distance from the main outlet ditches, and as a result the surface water does not run off after a rain in time to prevent some hatching. To remedy this your office kindly undertook to provide the means for labor and oiling this territory. The first oiling done here was on May 9th. From this date up to the first of October an expense of $25 for labor (consisting of 16 days' men, at $1.50, and one day horse hire, at $1) and $51.80 for 20 barrels of oil containing 1,036 gallons at 5c., or a total expense of $86.80, was incurred. It was necessary to treat the meadow four times during this period.

The first work of oiling pools was done on May 11th and continued up to November 14th. The catch-basins were oiled once in May, twice in June, once in July and once in August. In the intervals between the oilings samples were taken from numerous catch-basins to find out whether any larvæ were present, and the oiling was done as soon as they appeared. Our own horse and wagon were used, and two of our inspectors detailed to this oiling, so no additional expense was incurred for labor. The number of barrels of oil used was 68.

AMOUNT EXPENDED.

The total amount of funds available and expenses incurred now follow:

FUNDS.

Appropriations—City Council	$500 00
State (contract with W. F. Reider)	300 00
Contributions—Private citizens	661 50
Balance—Cellar fumigations	7 95
Abating mosquito nuisance on private property	36 00
From Health Account for oil, tools, &c	293 36
	$1,798 81

EXPENSES.

Oil— 68 bbls of 3,572 gals., at 5c	$178 60	
Cr., 4 Formalin bbls	4 00	
		$174 60
Boots— 23 pr. Storm King, at $4.16	$95 68	
4 pr., at $4.75	19 00	
		114 68
Tools— 20 Hooks, at 55c		11 00
Pipe—		5 90
Labor—Cutting brush and cleaning inland ditches		250 00
Cleaning out ditches on meadow		942 63
Contract (State with W. F. Reider)		300 00
		$1,798 81

SUMMARY AND CONCLUSIONS.

Much preparatory work can be done in the winter in cleaning out brushy pools and water courses which can easily be done when they are frozen over and free from the leafy growths of summer, in locating possible sources of breeding, and in cellar fumigations. This latter mode of getting at mosquitoes is expensive, and although to our present knowledge it seems well worth the outlay, it is really the wrong method to pursue in eliminating them, as the most efficacious manner is to remove their breeding places or to destroy them in the larval stage.

We have been unable to find a satisfactory substitute to eliminate breeding in catch-basins besides oiling, which I think need not begin before the middle of May nor continue after the middle of September. These places are well below the surface of the ground, and the hatching retarded on this account. There is a considerable number of old drainage outlets which were formerly brooks and are year by year becoming more constricted on account of building operations and the construction of sewers whereby the surface water is carried away by these means. However, it is necessary to go over these every year to see that they are clear and perform their functions as well as not being breeders in themselves. There are a few rain water cisterns left in some sections which have to be watched. With the extension of the water mains these are being removed.

The salt marsh ditches should be gone over carefully and thoroughly every year, which should be started in February or March at the latest, and completed before the end of April. Each year the amount necessary for this will be less, as most of the ditches will keep themselves in good working order, but there will always be a certain number to get obstructed either by falling in of the banks by obstructions placed by salt hay cutters or others, and the natural stoppage due to sluggish flow and the accumulation of heavy grass from the banks which often falls in when the adjoining meadow is burned over.

In conclusion, would say that mosquito extermination has become a regular branch of the work of our health department, and that few recognize how great an amount of time is devoted to this and how much territory is covered and work done with the amount expended. While the house mosquito has been a pest in some parts of the city during the past summer, yet we know that it would have been infinitely greater if we had not carried on our campaign. We also know that one community may suffer from the lack of interest in another. So far as salt marsh mosquitoes go they have ceased to become a pest. The work done by the inspectors from our office both in the inland and on the marsh is making a great stride toward solving the mosquito problem, although the force is entirely inadequate to completely cover the territory which is necessary. It is to be hoped that more men can be detailed to this work so that all hands may be ready for an active start before next spring.

I thank you for your many helpful suggestions and financial support, and assure you always of our hearty co-operation.

SUPPLEMENT TO THE REPORT REFERRED TO BY MR. RICHARDS.

The following mosquito breeding places were located by Mr. Henry H. Brehme, in Lyons Farms, October 30th, 1911:

The first section is located east of the main line trolley, south of the Lehigh Valley railroad. This place is a *pipiens* and *Anopheles* breeder, and should be filled about a foot or fifteen inches, which will eliminate it forever. Oiling will do some good.

The second section is a small swampy place which is located near Miller's coal yard. This is a *pipiens* and *Anopheles* breeding place and should be filled. Oil could be used as a palliative.

The third section is the brook which runs down on the north side of the Lehigh Valley railroad, west of Elizabeth avenue. The only thing that can be done here is to keep it clean, so the water has a good flow.

The fourth section is a dirty swamp, south of the Irvington branch of the Lehigh Valley railroad and the Glorioux plant. This place is an *Anopheles, pipiens* and *sylvestris* breeder. The only thing that can be done is to deepen the brook and drain into the same.

The fifth section is a large pool which is located on the west side of the West Elizabeth station of the Lehigh Valley railroad. There was *pipiens* breeding found here last season. The only thing that can be done here is to oil, as this water all comes down a brook and forms a large pool.

The sixth section is a swampy place which is located on the west side of Prospect street, north of Conant street. This is the place where the lady would not let your men oil last summer. These premises should be filled in.

The seventh section is a large *pipiens* breeding pool which is located on the east side of Prospect street, north of the Schuler property. This place should be filled and oil will do some temporary good. I saw very many old cans and pails dumped along Prospect street. These will all make breeding places for *pipiens*.

The gutters in Lyons Farms are in very bad condition and should be kept clean during the summer.

The eighth section is a large pool which is located on the east side of the Lehigh Valley railroad just south of the West Elizabeth station. The only thing that can be done here is to oil, as it cannot be drained and will take a long time to fill it.

The following breeding places were located in Union township October 31st, 1911:

The first section is a *pipiens* breeding place which is located on the west side of the Lehigh Valley railroad about four hundred feet south of Long avenue. This place should be filled or cultivated out of existence. It is on the property of the Elizabeth Nursery Company.

The second section is a *pipiens* breeding place which is located on the east side of the Lehigh Valley railroad just north of Salem road. This place is also on the property of the Elizabeth Nursery Company, and the best thing to do here is to fill it in.

The third section is a very dirty swamp which will breed *pipiens, Anopheles* and the woodland species, and is located from the side of Long avenue almost to the Lehigh Valley railroad, along the brook which comes from the Irvington branch of the Lehigh Valley railroad and flows south across Salem road. The only thing that can be done here is to deepen the brook and drain into it. No doubt Elizabeth got a good many mosquitoes from this swamp last summer.

The fourth section is a small swampy place which will breed *pipiens* and *Anopheles,* and is located on the west side of Baker street between Long and Silver avenues. This place can be drained and oil will do some good until permanent work can be completed.

The fifth section is a small swampy place where *pipiens* will breed and is located on the north side of Boston avenue about two hundred feet west of Baker street. This place can and should be drained.

The sixth section is a small ditch which is located on the east side of the Lehigh Valley railroad just south of Salem road. This ditch will breed *pipiens,* and the best thing to do here is to fill it. Oiling will do some good.

The seventh section is a swamp which is located about one thousand feet east of the Lehigh Valley railroad and about one thousand five hundred feet south of Salem road. This swamp will breed *pipiens* and this section can be drained into the stream on the south of it.

The eighth section is a swamp which is located on the west side of the Lehigh Valley railroad. This swamp will be a bad *pipiens* and *Anopheles* breeding place. The largest part of this area can be drained, but some oiling will have to be done here for a time at least.

The ninth section is a swampy place which is on the west side of the Lehigh Valley railroad about six hundred feet north of Morris avenue in Townley. This section looks to me to be a bad *pipiens* and *Anopheles* breeding place. A few ditches cut here to the brook on the north of it will drain this place. The gutters along North avenue, just east of the ice ponds, are in very bad condition, and I saw much water in them to-day, which no doubt was the case last June and August when we had so much rain. These gutters will make good *pipiens* and *Anopheles* breeding places.

I also wish to state that where there is any dumping of ground or ashes done by a contractor, he should be compelled to level it off so no holes will exist.

It is my opinion that Elizabeth must have gotten millions of mosquitoes from these sections of Union county.

SALT MARSH PROBLEMS.

Kearny Township.

For some time I suspected that north of the line of the Pennsylvania railroad, between the Hackensack and the Passaic rivers, there was some territory on which salt marsh mosquitoes bred, that found their way into North Newark and the communities directly west. It proved impossible, however, to demonstrate this. There was always Point-No-Point with an enormous number of breeding places, and mosquitoes in any quantity present, and always when we investigated the territory north of the railroad either no larvæ at all among the cat-tails, or such a scant scattering, that it did not seem possible that they could be charged with producing the swarms found in the various communities.

The building of the new line of the Pennsylvania Railroad Company parallel with the old line and the changing of many of the

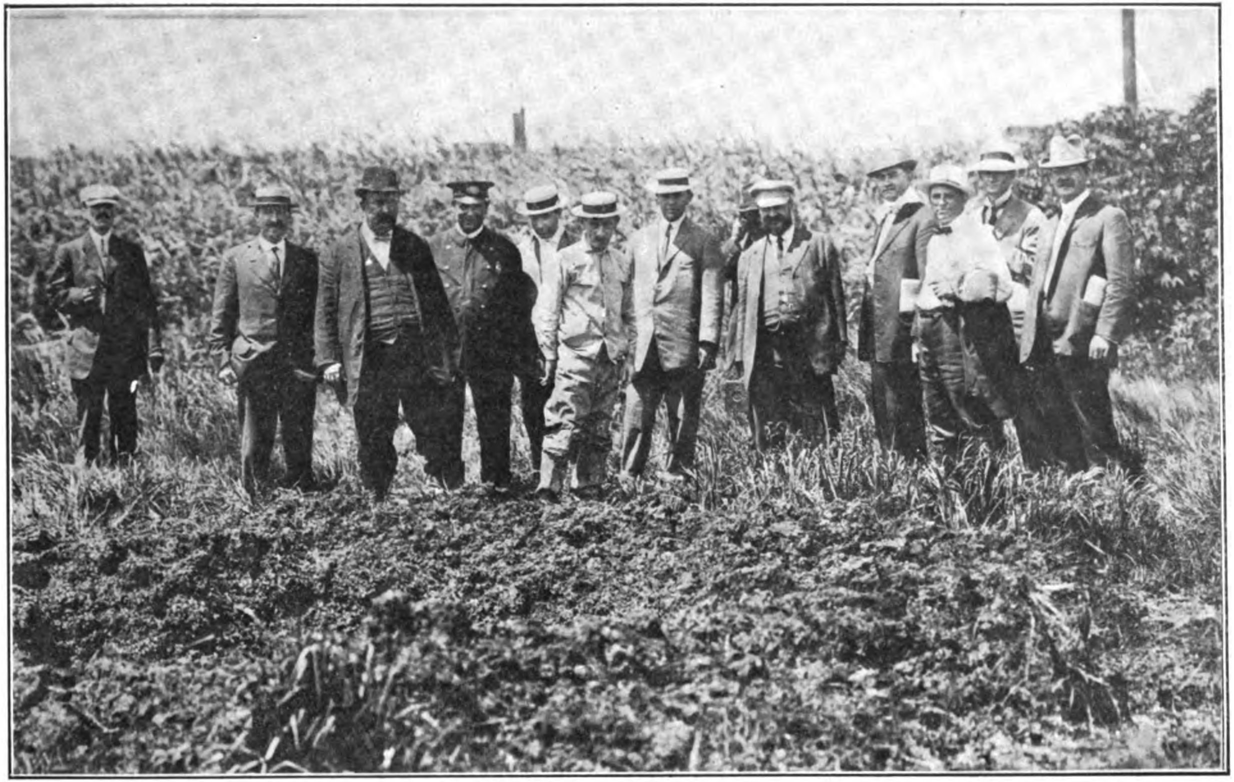

Figure 3.

Officials and others interested in dynamite experiment on Kearny Meadows. Left to right: Reporter; J. G. Lipman, Dir. N. J. Exper. Sta.; H. H. Brehme; A. E. Geissler; Reporter; W. C. Hartig; Reporter; J. B. Smith; Reporter; J. W. Dobbins; E. W. Stafford; Wm. Delaney.

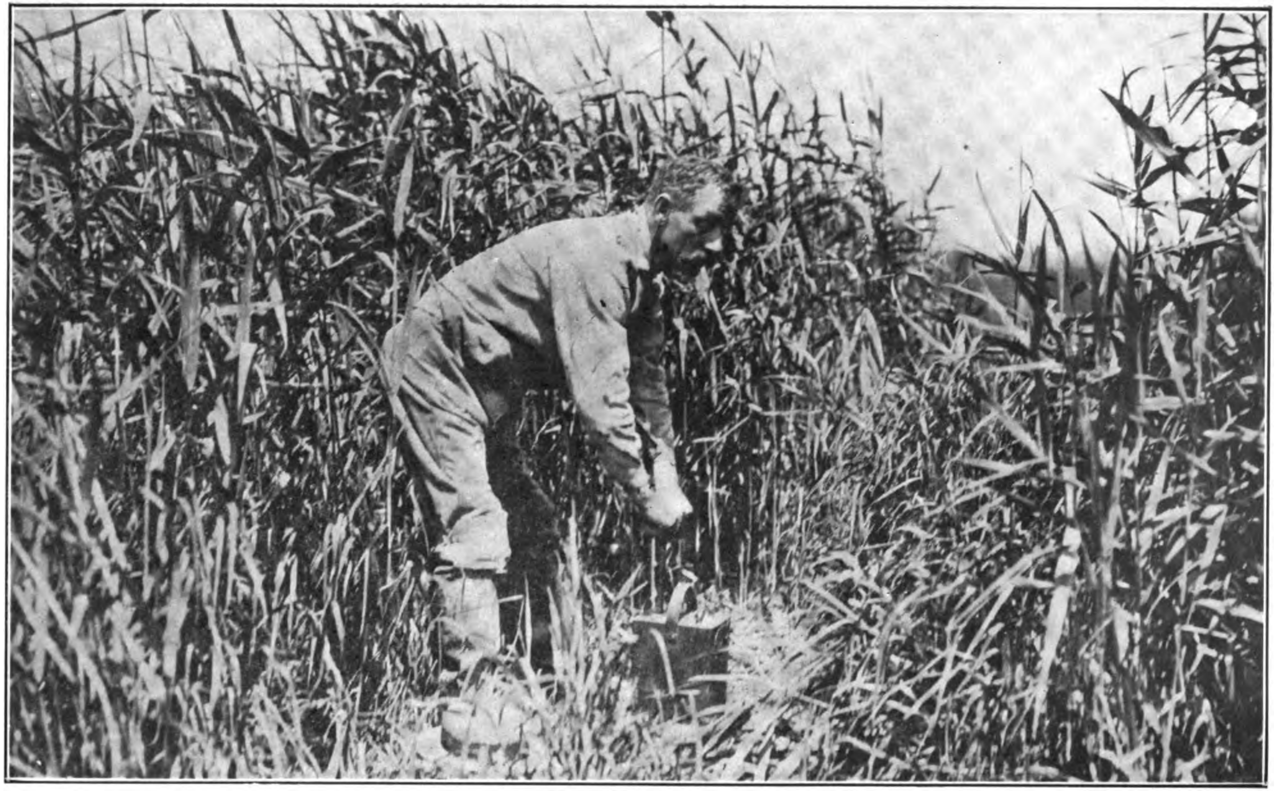

Figure 4.

W. C. Hartig ready to set off a blast.

roadways across the meadow during the latter part of the season of 1910, led to a re-examination of the whole territory in the very early spring of 1911, and developed a condition of affairs that was utterly unexpected and illuminating.

It was found that very early in the season, long before we had under ordinary circumstances anticipated finding larvæ on this territory, full broods of *cantator* developed here, and that the entire area between the Pennsylvania railroad, the new line of the electric road and between the new line and the turnpike, was really a virulent breeding territory, to a very restricted extent. For years advertising signs had been put up on this meadow. These lasted for a season, or sometimes only part of a season, were blown down and then partly torn out, leaving holes. Hundreds of holes were over the meadow, and it turned out that every one of those holes was full of wrigglers. When examinations were made in April, a perfectly terrific brood of salt marsh wrigglers was found over all this territory, and almost all in these small holes.

The problem here was a distinctly unfortunate one and a difficult one to deal with. The railroad embankment, from the Hackensack to the Passaic, is solid, or with only a single break near the city of Newark. There is no way of getting the water from north of the railroad dam to the Passaic river, and the Passaic at high tide is almost at a level with the meadow itself. The run along the length of the railroad dam from the Hackensack to the Passaic was altogether too great to make it possible to contemplate a cutting through from side to side, and we were left, in addition, with a pocket between the steam road and the electric road of the Pennsylvania railroad.

After consultation with Mr. Brehme and Mr. Manahan, we decided that a large measure of relief could be obtained by opening up some of the old ditches that were on the meadow, and forming long, deep and rather wide channels which could be stocked with killies. They were really lengthy ponds that were being created and ditches to drain into them. This would centralize the water-supply and would get it out of the holes, and, at the same time, give us material to fill a large percentage of the holes so as to do away with the breeding places.

Three separate localities were dealt with in that way, involving an expenditure respectively of $900, $600 and $600, a total of $2,100. This work was done immediately and several thousand feet of ditching was put in—narrow and wide—covering an area of several hundred acres. Later in the season practically no breeding took place on this territory, and that has been the experience in past years. This territory is a very early spring breeder only, but it does supply that early flight of mosquitoes that gets into the Oranges, into Nutley, Belleville and through that territory during the early days of May.

Attention having been drawn to this territory, I kept both Messrs. Henry and Herman Brehme on that section of the meadow and at the edge of the marsh bordering Kearny until another distinctly unpleasant and unsatisfactory condition of affairs was developed, for which, up to the present time, no cure has been found.

Kearny sewers into the Passaic river through a narrow stream rather more than a mile in length, known as Franck's creek. This enters the meadow at Schuyler avenue, runs south through Kearny meadow, in a general sort of a way parallel with the Passaic river at some distance inland, and over it, crossing the lines of the Erie, the Greenwood Lake, the Delaware, Lackawanna and Western railroad, the Newark turnpike and the Pennsylvania railroad before it empties finally into the Passaic river. It crosses the turnpike and the railroads through culverts that are no larger than absolutely necessary to carry the water, and the stream always runs bank full.

At one time Franck's creek undoubtedly ran through the meadow itself, and had a bottom that was lower than the present level of the meadow. In the course of time the sediment from the sewage filled up the bottom until the bottom was level with the top and the edge of the surrounding banks. Then under pretense of cleaning out the bottom of the stream, a foot or two was taken out from the bottom of the stream, piled along the edge of the bank and the stream was given an artificially high bank. This has been done two or three times, until at the present time, between Schuyler avenue and the turnpike, the bed of the stream is in most places higher than the level of the surrounding meadow, and the water is kept in this sewage stream by artificial banks made up of pasty sewage.

It goes without saying that winter frosts and the work of muskrats cut through the banks here and there, and the water instead of running through the stream and into the Passaic river, spreads over the meadow. This means acres of marsh land flooded with sewage during a large portion of the summer, furnishing ideal breeding places for mosquitoes of all kinds, and under conditions that make it simply impossible for us to deal with them.

There are at least a dozen places on the west bank of Franck's creek where there are breaks through which the Kearny sewage flows through the creek bank over on to the meadows and forms sewage pools. Most of the mosquitoes that breed on that side are fresh water mosquitoes—house mosquitoes, malarial mosquitoes and that type of mosquitoes that we know as *sylvestris.*

On the east bank of Franck's creek there are not so many breaks; the amount of sewage is not so great and the species that are bred there are the salt marsh forms, *cantator* and *sollicitans.* The bulk of all salt marsh mosquitoes that are found in the North Jersey towns after midsummer come from this territory.

It is utterly impossible for this service to do anything to remedy the condition that exists here. The matter has been brought to the attention of the local board of health and has been brought to the attention of the municipal and State authorities. They are fully advised of just exactly what the trouble is and what must be done, but up to the present time no disposition has been shown to do away with the trouble.

The conditions are not beyond control. It would require first of all a cleaning out of Franck's creek from the point where the sewer water enters it at the meadow to a depth of six feet at least, running uniform to the Passaic river and for the full width of the creek. That would be sufficient to take all the water that would come into the creek from the sewers and also the surface water from the meadow. At the entrance into the Passaic river there should be a receiving basin of 50 feet square and 10 feet in depth, with a rotary pump from which the sewage received through the channel of the creek could be pumped into the river continuously. That would render the flow independent of tide, and would take everything that would come down the creek under all circumstances. It would prevent the clogging of the stream and it would keep a continuous circulation of water, so as to prevent anywhere the covering that would permit the breeding of mosquitoes.

Something of that sort is needed as a sanitary measure. As the matter stands at the present time Kearny maintains a nuisance that is a disgrace to its own civilization and to the civilization of the State in which it is allowed to occur. Incidentally, nothing that can be done in this section of the State will do away with the mosquito pest completely so long as this condition of affairs is permitted to remain.

One thing offered a chance for getting some at least of the surplus water off this Franck's creek meadow area. If the underlying substratum was gravelly and porous there was a chance of opening up an underground drain, or series of drains, that would take off the surface water. The surface itself was covered with from six to eight inches of solid slime and mud which, baked to a dry leathery consistence in the sun and became tough and leathery under the influence of moisture, impervious in each case to ordinary drainage.

The Du Pont Powder Company was advertising dynamite for agricultural purposes, and particularly for sub-soil drainage and for deep ditching, and it occurred to me that possibly we might be able to use the dynamite to open a way out for this surface water. I therefore communicated with the Du Pont Powder Company at Wilmington, Delaware, and for a period of several months was in communication with their experts and operatives in a line of work in which they furnished all the labor and technical skill, while, on behalf of the State, I paid for the material used. The Kearny board of health co-operated locally, and the inspector, Mr. Geissler, deserves especial credit for the efforts that he made to further the work that was done on the meadow.

Briefly stated, the idea was that a series of ponds would be blown into the marsh, parallel with Franck's Creek, at as great a depth as we could conveniently place them, with the idea that, if possible, underground water courses would be opened up and the water taken away and carried off through subterranean channels relieving the creek, if possible; but at all events the surrounding surface area and preventing the local breeding.

It was not until the last days of June that everything was in final readiness for the blastings, and then the authorities of the surrounding boards of health and the representatives of the various newspapers were invited to attend the shooting of the first ponds. A series of altogether some twelve or fifteen ponds was put in covering a distance of nearly half a mile, the deepest of the ponds about 10 feet in depth and the largest of them nearly 30 feet in diameter. They average, however, considerably smaller than that, and in every case they filled with water very shortly after the holes were blown. Very little influence was exercised upon the surrounding drainage. At no point was there any subterranean channels reached, and nowhere did we succeed in taking off any considerable amount of surface water.

It was noticed that the waters in these ponds cleared very rapidly. They were tested chemically at the laboratory, were found to be very strongly acid in reaction, to have a very large percentage of iron in solution, and that they would not support either fish or wrigglers for more than a short period at a time. Attempting to stock these ponds with fish, Mr. Henry H. Brehme found that he could not make killies live in any of them for a longer period than twenty minutes, and at no time during his collecting did he ever find larvæ or pupæ in these ponds in any considerable numbers. There might be larvæ and pupæ in the water among the roots and grasses surrounding the ponds, but in the ponds themselves there would be little or no breeding going on, and the ponds as a whole could be considered as safe.

The cost of making the experiments amounted to about one hundred dollars, and while the experiments were failures, the money was well spent in view of the information that was obtained in the course of the work that was done.

Point-No-Point.

This meadow has been under constant observation practically all season by Messrs. Henry and Herman Brehme, and whenever any breeding had been found Mr. Dobbins was notified. Mr. Dobbins undertook to keep this meadow free from breeding and fulfilled his contract in that respect very satisfactorily.

Up to the present year all the sand that had been dumped into this meadow had come from the Passaic river, and rather more than half of the meadow has been made entirely safe by a covering that brought it up to above ordinary high tide level. There was a nasty stretch below the point reached by the filling and along the line of the Hackensack river, and it was realized that until this could be reached by filling there would be some breeding going on at all times. Nevertheless even this could be reached to a very considerable extent by the proper use of oil, and during the season of 1910 the co-operation of the Jersey City and Newark authorities kept matters in very decent shape.

In 1911 arrangements were made by which one of the dredges was placed in the Hackensack river and some filling was done from that side. This improved matters very materially, because even where it did not entirely do away with breeding places it did cover an enormous number of eggs, and it made the oiling of some of the places a very much simpler and more satisfactory matter.

The East Jersey Water Company has a pipe line that crosses this meadow, and there are about eighty joints or places where jointings are made, and at each of these a hole is dug to give room to get at the joints conveniently. These holes are left open permanently, and they furnished ideal breeding places throughout the summer that had to be continuously looked after by Mr. Dobbins's men. Mr. Delaney has put himself into communication with the officials of the company and has tried to get them to see the importance of looking after these places, and another season it will not be necessary to do this sort of work at least.

Furthermore, the filling from the Hackensack river is going on now very rapidly and very large areas of ground are becoming sand covered. This has buried millions of eggs of *sollicitans* and *cantator,* which will, of course, never hatch, and it will do away with breeding places to just that extent. With this area covered, as it will be before frost, the last of the larger areas of salt marsh that can be considered as dangerous breeding points for supplying Jersey City and Newark may be considered as practically eliminated. It leaves us with the Kearny problem as the only one of considerable extent in this section to be dealt with.

Newark Salt Marsh.

The fact that this meadow had been allowed to get into bad condition by the Newark authorities was realized during the winter of 1910–'11, and several inspections were made to determine exactly what should be done by the city and what could be done to help out by the State.

There were two sections at Waverly and at Maple Island where the original ditching was not as complete as it should have been, and developments since the ditching work was first done had turned an originally rather good part of the meadow into a bad

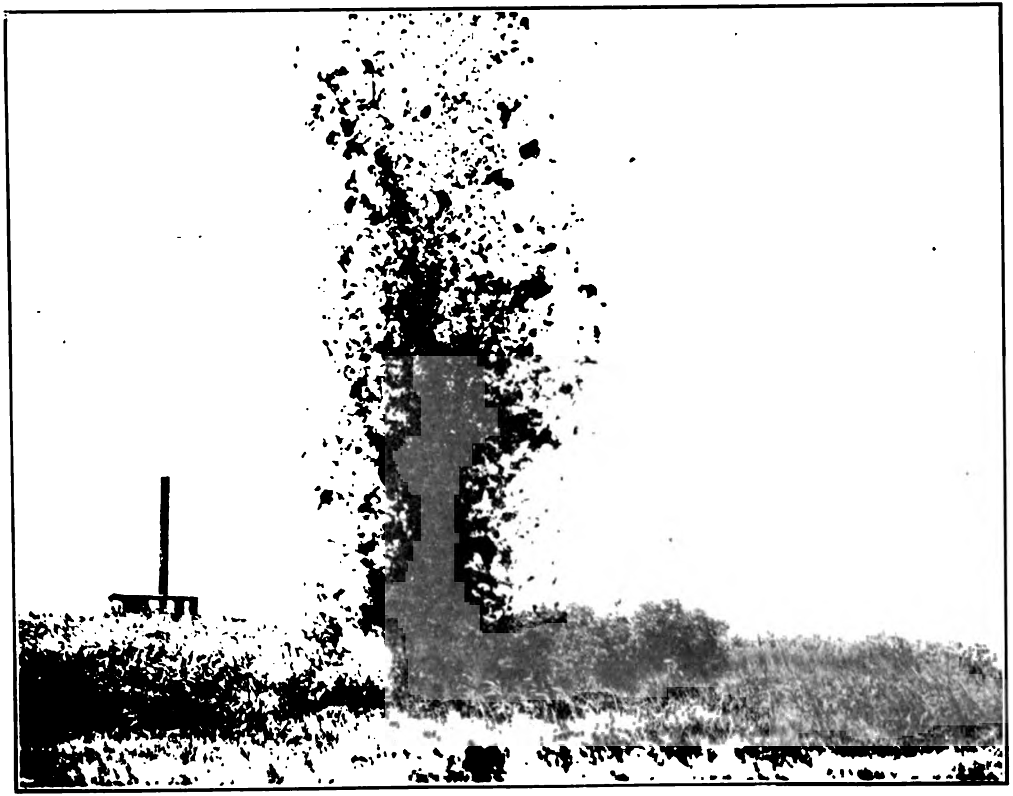

Figure 5.

The Dynamite Explosion. From Newark Star of June 29th, 1911.

breeder. There was a section, therefore, totaling just about two thousand dollars that could be reasonably charged against the State, and arrangements were made to have this work done prior to the breeding season in the middle of May.

On the other hand, there was a large area of territory properly ditched, but neglected by the city, where the ditches had been allowed to fill up with soft mud, and these it was realized should be charged against the city and should be cleansed by city work. To this work Mr. Dobbins refers in his report and refers as if the ditching relieved at that time was ditching originally put in by the State, which is an erroneous inference.

Most of the ditches referred to there were put in thirty years ago by haymakers and others who used the meadows for their own purposes at that time, and allowed them to fill up with soft mud thereafter. Some fourteen men were put upon this territory. The work was done under the supervision of an ordinary city foreman by day's work and was sloppy in every way. It was careless and cost altogether too much for what was finally accomplished. In the event, a small brood did get out in that territory, and it was necessary to take the men off too soon for the best interests of the meadow.

On the other hand, the work done by the State was done under contract. Over one hundred thousand feet of new ditching was put in, ditches thirty inches deep by ten inches wide, and every particle of water was taken from the marsh before the breeding season began. In the Maple Island and in the Waverly sections two hundred thousand feet of ditching can be added to the total amount, and practically no breeding went on there throughout the season.

Another mistake that was made on the salt marsh by the city gang was that the entire force was taken off before the middle of May, and therefore the forming pools in the incompletely cleaned sections were not kept under the necessary supervision, and from time to time, on high tides and heavy rains, small broods emerged and worked their way into the city that would have been unnecessary had they been kept under the supervision more carefully.

Practically no supervision of the salt marshes was maintained by the city of Newark during the summer. The only supervision that was maintained by the State was a monthly inspection made by the writer, Mr. Herman H. Brehme, for the benefit of the

North Jersey Mosquito Extermination League, and the outcome of the inspection was at each meeting read before this league. At this time Mr. Dobbins was notified of blockages and of interferences, but naturally enough no attempt was made to keep his meadows cleaned for him, nor to notify the persons concerned in the blockages.

Altogether up to the middle of September thirty-eight inspections were made by the State by the two inspectors employed in the city and on the marshes, and, so far as the meadows are concerned, everything was found in good condition until after the middle of September, when the high tides and heavy rains kept the surface water covered continuously. This, however, adds nothing to the danger, and although the meadows are continuously water covered, they are also covered with fish and there is little or no breeding going on over the surface.

So far as the salt marsh problem is concerned on the Newark meadows, that may be considered as under very good control, except where it is interfered with by the building or filling arrangements, or by other arrangements connected with the progress of improving the city or its surroundings. It is perhaps questionable whether it is a good plan to connect all the pools with ditches. It will tend to cut up the meadow a great deal more than is the case at the present time without adding much to its drainage, and it will tend to make it much more difficult for the haymakers and others who use the meadows for agricultural purposes.

Elizabeth Meadows.

During the early part of the season, the work of cleaning the ditches on the Elizabeth meadows was done under the directions of Mr. Louis J. Richards, but largely with funds contributed by the State. Some funds, however, were collected by Mr. Richards, and for a period of nearly two months a large gang of men was kept busy in cleaning up meadow areas that had been ditched in years gone by, but for one reason or another had not been thoroughly cleaned up since that time.

As the first spring brood developed it became obvious that Mr. Richards's gang would not be sufficient to complete the work that was necessary, and I therefore authorized Mr. Brehme to engage Mr. Manahan with a gang of ten men to put in a few days of additional labor, which helped matters out and started the season in good condition. There was altogether about seven weeks of work done, much of it contract work, and therefore more thorough and more rapidly done than the work on Newark, and fully half a million feet of ditching was gone over and cleaned during that period.

In previous reports the conditions of the Great Island section have been sufficiently set out, and it has been explained how it is that this territory cannot be made to drain under normal conditions. The arrangement that was made during the present season was, that Mr. Richards was to furnish the labor and that I was to furnish the material and the machinery to cover the Great Island section, and determine whether it was not possible to keep that oil covered, and thus to practically prevent mosquito breeding, even in the territory that could not be drained.

On April 21st, we first found a very heavy brood of larvæ in all the pools around the island; enough to flood the city if they had been allowed to get out, and in such position that it was simply impossible to drain the insects off. Two days' work with oil sprayers sufficed to go over the entire territory, and as the work was supervised by Mr. Richards and Mr. Brehme, it was thoroughly done, so that on the 26th the report was that practically every larva on that entire section was killed off.

Conditions during the early part of the season were good there, and not until June 3d was a second brood reported on this meadow. This brood was not quite so promptly treated as should have been done, and the result was that some mosquitoes were permitted to escape into the city from that territory; but very few actually did escape, and in the latter part of July we got ahead of a brood about the 28th of that month from which probably not a single specimen got into the city—an unheard of record and one which kept that section of the city entirely free from marsh mosquitoes at that season of the summer.

For the balance of the summer and until well along in September the meadow was kept under supervision, for it was established that there is no difficulty whatever in keeping the mosquitoes on the Great Island section of the Elizabeth meadow in complete subjection. It means some waste work, and it means doing over some work twice to suit weather conditions; but the mosquitoes can be absolutely kept out of the city from this territory.

On the other hand, it is a question whether the matter ought to be allowed to go along in just the way in which it is going at the present time, and to be a burden for years to come upon the city and upon the administration of the local boards of health. The railroad will want increased concessions across the marshes. They will have to have them. They need the facilities and they need wider and possibly even more solid embankments than they have at the present time. That means in every case the filling up of additional ditches and further interference with drainage. The present single track interference across the meadow will not be sufficient for long, and any further interference will of necessity make matters worse and worse.

It seems to me that it would be the part of good engineering and good policy on the part of the railroad company, and certainly the part of good policy on the part of the city, to insist upon planning their work at the present time in such a way as to permit of the cross drainage of this meadow from the highland at the west to the bay at the east. There will not need to be more than one or two cuts across the embankment, and if those cuts are put in at the proper places and properly guarded they will in no way weaken the railroad line of way, and they will make possible the complete drainage of that quagmire that now lies west of the New Jersey Central railroad embankment across the Newark and Elizabeth meadows.

Linden Meadow.

In the Report for 1910 attention was called to the fact that in the course of improvements made on the meadows a sewer was cut carrying drainage from the highland to the bay, and without any regard whatever to the drainage conditions that had been established by the State in its mosquito work. Not the slightest attempt was made to maintain the continuity of the ditches, and when the sewer was completed one complete section of the salt marsh was again practically cut off from all connection with tide water. The condition was discovered by Mr. Herman H. Brehme, my inspector, soon enough, and the attention of the Linden board of health was called to the matter. They acknowledged the condition, but further than that I could not get them to go.

In the spring of 1911 I had Mr. Brehme make another careful survey of the territory. It was found that the matter was worse than before. The gradual packing in of the material in the sewer ditch continuing to destroy the sepage through the line of that ditch, leaving a considerable meadow area undrained.

It was determined from this survey that it would require five hundred dollars ($500) to put the meadow back into good condition, and the attention of the Linden board of health was called to the matter once more. They were also advised that there was a terrifically large brood of larvæ on the meadow at that time, growing very fast, and promising within a few days a good old fashioned flight of salt marsh mosquitoes for Linden and its surroundings.

The board met this condition promptly. I had offered to contribute two hundred and fifty dollars ($250) out of the State funds if the board would do the same, and would give the contract for doing the work to Mr. Manahan. Mr. Manahan had agreed to do the work for five hundred dollars and to accept the Linden township as one of the contractors, if they would give him a free hand to go ahead promptly and without hinderance.

This they did, and by putting on a very large gang under the general direction of Mr. Brehme, the danger spots were first of all attacked, and relief was given to the sections on which the greatest number of larvæ were found breeding. The rest of the work was done in a more leisurely fashion, and, on the whole, surprisingly few mosquitoes got out of this territory, considering conditions as they existed during the early days of May.

There was sufficient money to do quite a bit of cleaning of ditches, and it was all spent in that way, so that during the season of 1911 the Linden meadow remained in good condition, and with very few of the salt marsh pests hatching. Unless some other "improvements" are started this meadow will remain in good condition for another year or two to come, and it certainly is in very decent condition at the present time.

Woodbridge and Sewaren Meadows.

These are meadows that are always at the danger point, and which we have been keeping under rather close observation. Three inspections were therefore made by Mr. Brehme during the season of 1911, but conditions on the whole were always found pretty fair. Some sods were found in some of the ditches, but always lying in such a way that they did not interfere with the drainage.

It appears from the inspections made that the area between the New York and Long Branch railroad and the county road should get a little additional ditching. The spur ditches that were originally put in from the main ditches in this territory have filled up considerably, and a few new ones should be cut where needed. It is probable that twenty-five dollars ($25) would pay for all the work needed on this area.

The territory near Boynton Beach, which was partially blocked by pumping sand on it from Woodbridge creek, as we reported in 1910, is being gradually filled in altogether, and the breeding places are being eliminated in consequence.

The Barber Asphalt Company has built a plant on the west side of the New York and Long Branch railroad, and while filling in is still going on around the plant and its vicinity, no drainage has thus far been interfered with, but the place will have to be watched, and it is one of those that can be very easily turned into a very nasty and unsatisfactory breeding territory.

Carteret Meadow.

This belongs to the same series as the meadows just reported upon, and might have been left to take its chances with them, because it seemed to be in about the same condition as a whole; but more sods had floated into the ditches and there seemed to be a greater amount of interference with the drainage. It was deemed wise therefore to spend twenty-five dollars ($25) in cleaning up this territory, and that was done in early May. After that the drainage conditions were exceedingly good, and while no very close examinations were made there was nothing to indicate, at any time later in the season, that mosquito breeding was going on to any considerable extent.

Perth Amboy to Maurer.

No city has been more active during the season in its fight against the mosquito pest than Perth Amboy, and the local board of health has used its powers to the full extent in every direction.

The result is that some extremely good effects have been secured, and while there have been undoubtedly a great many mosquitoes in Perth Amboy, there have been not nearly so many as in years gone by, and the conditions are better for future work.

Perth Amboy is now almost in the condition of having most of its outside breeding places under control. The city, on the other hand, is located in a district in which there is an abundance of salt marsh and fresh water swamps and a great deal of low land. It has a large population of foreigners, some of them of the most ignorant description, and it is a population that will breed mosquitoes on the least provocation, or without any provocation at all.

Under the circumstances the problem before the local board of health is a serious one, and its organization has not been such as to measure up to it. This is not a criticism of the board, because they have done everything that it was in their power to do. On three occasions Mr. Herman H. Brehme went over the ground with one or the other of the officers of the board, and I went over the territory personally with Mr. Brehme, besides going over the ground myself from time to time as a trip through Perth Amboy was necessitated by my trips through the State for other purposes.

The Maurer meadow is practically within Perth Amboy, and while that territory has been ditched the ditches do not work well for some reason and block easily. On April 19th, Mr. Brehme was on this meadow with Mr. Kaletsch, the then president of the Perth Amboy board of health, and his attention was called to the conditions there. Within two hours afterward these conditions were being improved, and Mr. Brehme reports that during the balance of the season the Maurer meadow remained in very fair shape.

There is no doubt, however, that Boynton Beach, Sewaren, Woodbridge and Carteret add to Perth Amboy's supply of salt marsh species from time to time, and occasionally the Raritan meadows are also in fault.

Raritan Meadows.

I have a pretty good tab on the condition of the Raritan meadows on my own front porch at New Brunswick. Whenever any mosquitoes breed on that meadow, no matter how small their number, they find their way along the river and they visit me at the curve in the river where my house is situated. It seems to form a natural line of flight for them, and I always have gotten the full benefit of whatever happened down "on the banks of the old Raritan." Before my house was built, it was almost impossible to stay on the lot, because of the number of mosquitoes that scared off prospective builders, and later, when I established a garden, there were parts of the garden into which I never went at certain seasons of the year, unless it was absolutely necessary.

Conditions have changed. Since the Raritan marshes were ditched we rarely see *sollicitans* at all at New Brunswick. In some seasons it is practically non-existent. *Cantator* maintains itself and at times is offensively prevalent on the front porch. Then I know that something has happened down the river, and I can send Mr. Brehme down with positive instructions to find the source of the trouble rather than instructions to find out whether there is trouble.

So, it happened this spring, when, after practical freedom from mosquitoes during the early months, specimens began to make their appearance in June. Mr. Brehme reports altogether four inspections of these Raritan meadows. During the early part of the season everything was in good shape; the ditching was working well, the meadows had been largely burnt over and were dry, and on the north side practically every ditch and pool was free from standing water and absolutely without larvæ.

Conditions changed in June. The tides began to run high, the winds became adverse and there was rain enough to keep the upper section of the meadow water soaked. It was not that the drainage system was bad, but there simply was too much water to be carried off by the valley. The only help that could have been given, would have been to deepen the river, and that, of course, we were not in condition to do. While there was a heavy brood of killies in the streams there were not enough of them to take care of all the larvæ that ran up into the grassy holes near the edges of the highland, and the result was that in June there was a brood of *cantator* that got on the wing and into the surrounding territory.

After the wet conditions had disappeared the meadow gradually dried up again and remained dry until September, when there was a reappearance of the same conditions and the mosquitoes again made their appearance at New Brunswick. At that time I was in a condition when I did not care very much whether the mosquitoes were abundant or not; but I do know that they were not plenti enough to be troublesome in doors, because I had many a sleepl night, which would have been made seriously worse by the prese of mosquitoes.

There are ditches enough on the meadow. In some section little cleaning out of the ditches would do no harm, but the trou is rather a general inability on the part of the valley to carry all the water that accumulates in it at a certain season. There i terrific amount of water that comes down the stream during period of heavy rains, and that volume of water is increasing rat than decreasing each year as the surface wash becomes more tense, and at the same time the river shallows as the result of co tinuous sedimentation and causes a spreading out of the water ov a greater area.

What has been accomplished up to the present time has been t almost complete elimination of *sollicitans,* the reduction of *ca tator* to such a point that only a fraction of its former virulence mains, and each year it is becoming reduced in numbers, so th even this species is losing its hold, and would lose frightfully aft two or three favorable seasons. These favorable seasons meani not seasons of continuous drought, but simply seasons without e cessive rains grouped at one time.

Cheesequake Meadow.

Conditions on this meadow were good all season with the exce tion of the middle of June, when a brood got out, due to rains a tides, and again late in September when a light brood got out, d to the blocking of one ditch near the snipe grounds.

The first inspection was made on May 4th. At that time t meadow was in perfect shape, not a single larva was found on and the ditches were working to perfection.

No mosquitoes got off this meadow until the middle of Jun and then the weather conditions were such that the ditches we not capable of taking the tons of water that shot down the hillsid from the heavy rains and the water that backed up with the hig tides. After this brood died off, which was in a few days, nothi hatched from that meadow again until the middle of Septembe when there was a series of high tides and rains that kept th meadow wet, and the blocking of one ditch to keep water on the scalds to shoot snipe.

The blocking of that ditch takes place every season, and a watch will have to be kept on that place in the gunning season. The blocking of this one ditch means that nearly an area of two acres is covered with water, and in such a space a good supply of mosquitoes can emerge.

Morgan or Lawrence Harbor is becoming a great summer resort. Four years ago, or before the drainage work on the Cheesequake meadow was done, only a few natives lived at Morgan, and these were only the bridge tenders and boathouse keepers. The second year after the work was done a few campers pitched their tents. These increased in numbers with a few bungalows in 1910, which was due to the fact that what was once an uninhabited mosquito section was turned into a mosquitoless town. Where nobody lived in 1907, thirty-three tents and nineteen bungalows were up during the season of 1911.

While the salt marsh mosquitoes are under control, the *pipiens* are getting a hold due to the number of barrels and tubs used by the campers, and it will mean that these people who have barrels, &c., on their premises will have to be taught how to keep their water receptacles either covered with bags or screened, or they will have to suffer from this little trouble maker.

Marquis Creek Meadow.

This meadow was ditched under great difficulties in 1907, many spots being found that contained red sand, and which was thought at the time would not hold a ditch.

The ditches after nearly four years were found to be in as good a condition as at the time they were put in.

This area is only about eighty acres in size, but there were some ideal mosquito breeding places on it, which have been so thoroughly wiped out that no breeding has taken place since the work was done.

The *Cliffwood, Matawan, Keyport, Lorillard, Keensbury, Belford* and *Atlantic Highlands meadows* were only inspected once during the last season. Everything was good from the reports that the natives gave. The only time that they were troubled with mosquitoes was about the middle of June, which was the same time that mosquitoes got out on the meadows further north.

Monmouth Beach.

This was one of the first meadows that was undertaken in the State, and the ditches that were put in there were those that followed closely on the old Massachusetts line of six inches by twenty-four inches. The work was well done and for several years was satisfactory, but there was considerable wash from the steamers, and it was found that it needed rather more looking after than was justifiable in what purported to be a permanent piece of work.

Under the circumstances the whole matter was taken in hand again by the association that did the work in the beginning, and what was left of the meadow has been re-ditched with ditches cut to the modern depth of thirty inches and width of ten inches. A good portion of the territory that was originally improved along the Shrewsbury by this first work has been permanently reclaimed, and the entire character of the surroundings has been changed.

Water Witch.

The problem at Water Witch includes really that at Highlands and practically that which extends from the landing at Atlantic Highlands to the Highlands station. There is here a stretch of marsh land at the foot of the bluff, a small part of it typical salt marsh, another small area at the extreme base of the bluff typical fresh water swamp, and intervening spaces which may be dirty in either direction.

The largest natural breeding area is for salt marsh mosquitoes and extends irregularly into the bay. It is being vigorously improved, a goodly portion of it has been filled up and reclaimed and camps are being built on it. The length of time that this will remain a mosquito breeding territory is necessarily very short. Every year sees additional buildings added and additional filling done.

Just back of this first line of improvement and between this line and the railroad right of way is a swampy area, in most part fresh water swamp and in goodly part territory that will breed not only ordinary house mosquitoes but the *Anopheles* or malarial mosquitoes as well. Water courses come down the bluff and down the elevation which are not carried off through any natural streams into the bay, but are allowed to lose themselves in this low swampy area through which the railroad runs. Two or three ice ponds assist in giving character to the territory and help in fixing the general lay-out of the land and water.

No settlements are taking place at the foot of the hill or along the direct line of the railroad, but along the top of the hill and everywhere on the crest of the elevation expensive and elaborate residences are being raised.

Sanitary conditions on the hill are good as a whole. The sanitary conditions on the flats, where the campers are during the summer, are generally fair and can be made good very readily. Sanitary conditions in the intermediate spaces are very poor. The residents on the hill section of Water Witch have taken this matter in hand and are trying to improve conditions. They have accomplished a great deal and they will undoubtedly accomplish a great deal more.

With a little co-operation on the part of the local authorities and of the railroad operating between the pier and Atlantic Highlands, matters can be very much more improved, and this whole territory can be almost completely freed from mosquitoes at a very small sum of money and kept freed thereafter at the expenditure of an exceedingly small sum annually.

Manasquan.

Only two inspections were made on this meadow. On the first inspection, which was on July 18th, the meadow was found in superb condition. Everything was working nicely and no larvæ or adults were found, and from the reports of the natives no mosquitoes were noticed up to that time.

Conditions were found different on the second inspection, which was made on August 2d. The tides in that section of the State had been running high for a week or ten days before this inspection was made, and while the meadow was found dry and in good working order, such an enormous amount of water was thrown over the meadow during this series of high tides that the ditches could not drain it off fast enough, and the pools were kept wet enough to enable a half-starved brood of *sollicitans* to hatch. But fortunately most of these stayed on the meadow, and the inhabitants were not troubled much.

Conditions were good until late September, when the same conditions that existed in early August again reappeared.

Barnegat Bay Shore.

The importance of Barnegat bay as a summer resort and the enormous possibilities of that territory must be realized by every person that makes even the most casual study of the summer resort problem, and no one who spends even a small portion of the summer at any of the resorts along the Jersey shore can fail to appreciate the importance of the mosquito problem.

It is literally within the bounds of truth to say that the mosquitoes have killed off several flourishing settlements, and that they have absolutely destroyed millions in property values along this coast. Nevertheless, and in spite of the past, settlements are slowly increasing, and as improvements are being made here and there, their natural influence in reducing the quantity of the pest induces the further extension of the settlements.

Bay Head, at the northern end of Barnegat bay, marks a point of division along the coast, is a narrow strip with a beautiful sloping beach that extends for miles with comparatively few breaks to Cape May. This strip varies in width and a good deal in its general make-up. Essentially, however, it is a ridge of sand hills, the western shore sloping very gradually into the waters of Barnegat bay and forming a salt marsh. At the present time there is no outlet at the northern end of Barnegat bay into the ocean. There is no tide, the waters of the Metedoconk river keep the upper end of the bay practically fresh, and a true salt marsh does not really exist at Bay Head and its surroundings except as a remnant. The bay widens, and there is a broad fringe of salt marsh extending along its western shore, forming the eastern border of the highland proper. On both shores of Barnegat bay, therefore, there is salt marsh, and salt marsh under conditions which favor the development of mosquitoes to the utmost.

In the course of the work that has been done by my office the entire stretch of salt marsh lying along the west coast of the bay extending from Bay Head to Toms River, has been ditched and drained and the salt marsh breeding places have been pretty thoroughly eliminated from a goodly portion of that area. Mr. Brehme's report on the territory between Bay Head and Toms River speaks for itself. It gives the existing conditions and shows what is necessary to bring the area into satisfactory condition.

The conditions along the narrow shore strip extending from Bay Head to Seaside Park were decidedly more complicated and more puzzling than those on the main land, and I hesitated about taking them up until the present year. In the first place, before the new State road, which now extends from Bay Head to Seaside Park, was completed, there was nothing in the way of a grade established or a continuous road, except the line of the railroad extending between the same points and turning west at Seaside Park across Barnegat bay for Toms River and Philadelphia. At Seaside Park some drainage work was done years ago, and conditions were decently good, so far as mosquitoes were concerned. At Berkeley and Ortley the places had been killed off by the mosquitoes, and the other places along the line of the railroad had just barely maintained themselves.

I had covered this territory myself, on foot as well as in the train, and it had been covered by some of my assistants as well. I knew just exactly what the breeding conditions were and knew precisely how very difficult it would be to do permanent work in a territory where a permanent supervision could not be maintained.

The line of the railroad extending parallel with the ridge of the sand hills is built back of the sand hills, and as close as is deemed safe to the edge of the salt marsh. This shelters the embankment from the sea, and the whole line of way is protected by sand hills directly on the coast. Every spur and every strip of sand that extends into the marsh is cut by the railroad, and equally every spur of marsh that extends into the sand hills tends to become blocked by the railroad embankment if it is not directly and deliberately blocked when the embankment is put in.

In consequence, there is, to the west of the railroad, a tolerably good stretch of salt marsh which is easily ditched and easily drained and freed from mosquito breeding places. East of the railroad and between the embankment and the sand hills there are pockets of marsh area that sometimes hold water for days and weeks and furnish ideal breeding places for mosquitoes. Among the sand hills themselves, where the shore strip becomes rather wide, some of the low places become sodden, so that the water does not drain off readily and become covered with a growth of grass or the like. These also, under favorable conditions, will breed mosquitoes in great quantities, and that sort of breeding place may occur anywhere along the line, and I know does occur at numerous points between Bay Head and Seaside Park.

As a rule, in the laying out of improvements, the salt marsh area, particularly where it is at all broad, is left out of consideration and the improvement consists of a leveling of the sand hills extending back as far as the line of the railroad, or a little beyond. At the present time, the tendency is to complete the work between the shore line and the State road, and to do only what is absolutely necessary between the State road and the line of the railroad, leaving the territory between the railroad and the bay entirely undrained. The natural result is that it has become an exceedingly expensive proposition to deal with the territory, and it has seemed to me not an appropriated expenditure of the State's money to benefit a line of territory that will be put upon the market at high prices within a few years and without any return to the funds expended by the State.

I decided, therefore, from the beginning, to omit from all scheme of improvement the whole territory between the shore and the State road, and on this territory the number of breeding places is really very small, except in a few favored localities, such as Ortley, where breeding places extend between the hills clear to the shore. However, the owners of the lots there can, by combining and contributing a not too large sum per individual, secure practically complete immunity.

I have also decided to omit work in most places between the State road and the line of the railroad, because there was no sort of guarantee that this work would not be interfered with by "improvements" as soon as they began to be made, and I concluded that it would be time enough to take part in these improvements when they were put upon something like a permanent basis by either some land company or by some borough or other municipality taking up the work.

Only where a piece of genuine salt marsh extends into this intermediate strip have I taken up the work at that point. On the other hand, practically all the territory between the railroad and the shores of the bay have been drained and ditched during the past year or two between Bay Head and Seaside Park.

One of the reasons that has decided in the action taken, is the condition of affairs found developing at Bay Head. Here there was an area of salt marsh that extended directly back for a considerable distance. It was completely ditched and the drainage extended back so as to take the water to the edge of the highland. While dredging work was going on, the yacht club and other organizations interested, arranged for the filling of a section of that territory extending from the edge of the bay part way to the highland. So far as the filling extended, the work was thoroughly done; the breeding places were completely abolished, but there has been left a basin, which is now completely removed from the effects of salt water, will grow up with fresh water plants, and will form an ideal place for breeding *Anopheles* and the ordinary house or *pipiens* mosquito. Conditions just at that point are now really worse than they were before, and the whole thing might have been avoided by spending just a few dollars more at the time the dredge was pumping in the sand. It will cost now several hundred dollars to do the work that could have been done for probably less than one hundred dollars at the time the original undertaking was being carried on.

Brick Township.

This strip extends from Mantoloking on the north to Dover township on the south. The work here was started August 1st with twelve men. The meadow was first looked over in May, and again in July, and it was estimated that 40,000 feet would be required to drain all the danger points, and this proved to be the case. The first ditches that were cut near the northern line were found to have a layer of sand about six inches below the surface, and this layer was about five inches in depth. Then a genuine marsh soil was encountered, which could be cut down to the normal thirty-inch depth and give us good outlets for our ditches.

Two weeks before the work was started the meadow was flooded by a southeasterly tide, and this remained long enough to give rise to a large brood of *sollicitans* which, while they were intensely annoying, had the advantage of locating the breeding places as the work went on. August 5th there was another high tide, which did not prevent the continuation of the work, but again gave us opportunity to locate the danger areas, and in fact during the whole period of time that work was under way on the meadow, occasional tides or slight storms kept the meadow in such condition as to point out the danger territory.

Most of the ditches were run into creeks or coves wherever such existed. We have found by practical experience that where we have natural creeks or ditches they seem to remain open indefinitely, and for some reason or other do not become blocked with seaweed or other rubbish. The meadow was so very level that practically no filling had to be done, and ditches could be run to all danger points. The full amount of 40,000 feet of ditches was required, and the work was finished, inspected and found satisfactory on August 22d. The cost amounted to nine hundred and thirty-five dollars ($935).

Dover Township.

The work done in this township was between Barnegat bay and the ocean, and started at the Brick township line on the north and finished up at the Seaside Park line on the south. The borough of Lavallette lies about midway between these two lines, and owing to the impossibility of obtaining action by the board of health of that borough, the territory within its boundaries was not taken in hand with the rest of the work.

Work was started on the northern section September 14th, with twenty men under an agreement with Mr. Jesse P. Manahan. In a general way matters were found in much the same condition that we found them on the Brick township meadow. There was no difficulty in locating bad places, and to make things worse high tides set in, which put the meadow a foot under water for a part of the time. These tides on the Barnegat meadows are principally backed up water. Drainage comes in from the surrounding territory, and there is no way for it to get out into the sea. The number of inlets or outlets are so small and they are so narrow that it is simply impossible for the water to get away, and long before the water can run out the flood tide is again in control, and therefore it frequently happens that a continuous storm will maintain an apparently level tide covering the entire meadow. However, that is the condition under which part of the work on this territory had to be done.

The lines were run after the ditches were staked out, and while they were lying nearly a foot under water, nevertheless good and straight ditches were cut. The only disadvantage was that work was, of course, retarded. As it progressed toward the south conditions improved, the fall of the tide was greater, and part of the time the men were working dry shod.

In a good portion of this territory the meadow was very level and good and only had a few small depressions here and there; bad breeders, but so few in number that it was deemed wiser to fill them than to cut ditches. This, of course, is an advantage to the haymakers, which they appreciate and which they perhaps consider of much greater importance than it really is.

The work between the Dover and Brick township lines and the north line of Lavallette was finished September 20th, and a total of 45,000 feet were put in. Good drainage was assured over this whole area, which, as in the case of the other territory, was principally to the west of the railroad line.

The section south of the Lavallette line was then taken up and some very bad breeding places were found. The pools indeed were black with larvæ, and the men were set at once to work to get rid of the worst of these pools and get the larvæ into the bay for their own protection. It made it just so much easier for them to work and unnecessary to spend so much time fighting mosquitoes.

The ditches were staked out here and the work proceeded very rapidly, because weather conditions were favorable, and there were no adverse conditions of any kind. North of Ortley the meadow is composed very largely of genuine marsh land with some spots of sand. South of that point more sand was found, and in some places was so hard the ditches could not be brought down lower than 20 inches. These ditches run on the grade, however, and drain to the bottom of the meadow in all cases. A total of 40,000 feet of ditching was put on these meadows, and all of this was on the west side of the railroad. This work was finished on September 28th, inspected on the 29th and found satisfactory. The total cost was seventeen hundred dollars ($1,700).

Lacy and Berkeley Shore Strip.

The shore strip on which Seaside Park is situated and extending down to Barnegat inlet, is very narrow and has no more than the barest fringe of salt marsh along the edge of Barnegat bay to the south of Seaside Park. It is so narrow south of Seaside Park itself that it has not been deemed wise to put any of the State funds into any work along the sand hills.

There are probably some places in that territory in which occasionally some salt marsh mosquitoes breed; but they do that under such unusually abnormal conditions that it would be impossible without an expenditure of an altogether disproportionately large sum of money to avoid all danger, and the trouble is likely to come only either very early in the spring or very late in the fall, at a period when the interests of the resorts would suffer least. Under the conditions as they stand it was decided to allow matters to remain as they are, and to put it up to the local authorities to make the necessary expenditures whenever the interests of the various municipalities really demanded the expenditures.

Berkeley Township Meadow.

The contract for the work in Berkeley township covered 1,728 acres and was awarded to Mr. Jesse P. Manahan for six thousand dollars ($6,000) on August 3d. The specifications were sent to me and were received on August 5th.

I went down to Barnegat pier on August 7th to look the meadow over and select the most convenient place to start the work. There was some delay in bringing down the men, but the territory was gone over with the foreman of the machine gang on the afternoon of the 7th and on the 8th. It was found that the best place for the machine work to start was on the meadow just south of the Falkenburg meadow, which is about one-half mile south of the Pennsylvania railroad. It was found after the machine had been brought down from Toms River that work could not be started for two or three days, as the steering gear was broken in bringing it down through the sand roads in the woods, and the hand gang had not gotten down on the afternoon of the 9th. The matter was therefore left in the hands of the foreman who was told to start in case the men would come, where the work was staked out. (I left with you for Newark on the 9th.)

I went down to Barnegat pier again on August 14th. At that time the work had started with 16 men who worked the hand tools and five men were working the machine. It was at first thought that the meadow would be hard and sandy; but this was not the case, and ditches could be easily cut to the depth of from 26 to 32 inches. The best feature about that meadow is that the ditches could be cut on a grade—that is, it was no trouble to cut down 30 or 32 inches—at the outlets, and although they could not be cut hardly any deeper than 26 inches towards the upland, the ditches had sufficient fall to take off all the water. The work with both machine and hand tools went along nicely, and by noon of the 18th, over 20,000 feet had been cut, and the biggest part were hand-tool ditches. The owners by that time had noticed what the work was to be, and it spread rapidly along the line that the meadows were being improved instead of being ruined, as was at first feared by some of the owners.

The meadow was then in a very dry condition, due to low tides and no rain for some time, and while it was difficult to tell just where the most dangerous points laid, it was made easier with the help of the owners, who knew all the low points and where water would lie the longest. The owners by this time were ready to show everything and assist wherever they could. The work was kept on down towards Sloope creek with the intention of bringing the men back if necessary after the first high tide or heavy rain. (I returned on the 18th, after staking out enough work to last four days.)

On August 22d I went down to Berkeley township again and the work that had been done, which by this time had reached all of 35,000 feet was looked over and found to be all right, and the 23d and 24th the meadow was gone over with Messrs. Veeder and Lewis, both owners of large tracts of meadow. Both were anxious to get their own meadow property ditched to the best advantage, but at the same time not to have too many ditches. The meadow was thoroughly gone over, and, while the original plan was changed somewhat to make it easier to drive over, yet at the same time to assure the same results as on the plan laid out, it required as many feet of ditching as the specifications called for and nothing was saved.

There are several wide ditches on the Veeder and Lewis meadows which had not been cleaned since the day that they were cut and these had to be cleaned down deep. These ditches were four to five feet in width, and while drainage could have been gotten sufficiently for the meadows bordering on the east and south of these old ditches without tapping them, nothing could have been done with the meadows that lay north and west of the ditches. If the narrow ditches had been cut right through these old ditches without first cleaning them they would have filled right up with the soft mud that would run in from the old ditches in a very short time, and the work would have been for naught. It required considerable labor, but this was the only way that it could be done.

The hand gang was increased to 20 men on the 23d, and on the 24th, which was the day I left, about 43,000 feet had been cut. Work was laid out to last both machine and hand gangs for four days. The hand gang was keeping ahead of the machine, as they had the advantage by the machine having to be shifted so often.

The next inspection was made on those meadows on the 29th, and up to that time the work was going along in good shape. Late that afternon a storm set in which was terrific and flooded the meadow, so that practically every portion of it was under water. Work had to stop for two days as it was a continuous downpour. While it made it unpleasant for the men it was to their ultimate advantage in securing good results. The good and dangerous places now had to show up in a few days. The work at this time was near Sloope creek and nearly 100,000 feet of ditching was put in. (I left for home on September 1st.)

Conditions were again looked over as far as the work had gone on September 6th, which was just about six days after the heavy downpour and high tides, and the rain alone amounted to seven inches of rise! The first thing that was done was to look for spots where the water had not drained off, and while a stretch of nearly two miles in length and from a half to a full mile in width had been ditched when weather conditions were so dry that very little could be done except by going over every foot and locating and taking a chance. With all those odds against us everything was found to be in the best working shape except two places, both of them on the Falkenburg meadow just south of the Pennsylvania railroad. The hand gang was taken back, and as every danger spot was now marked it was cleaned up in good shape. This particular meadow was watched up to September 29th, and although there had been several more high tides and rains on that meadow, the water would not stay more than four days at the longest, and then the meadow would be perfectly dry again. The water on the undrained meadow north of the Pennsylvania railroad and south of Sloope creek remained stagnant, there being no chance for it to run off, and on the 7th a terrific brood of mosquitoes got out on those two meadows.

While some doubt was cast upon the drainage work by this, it was readily proved where these pests bred and where they did not breed by taking them over both drained and undrained territory, where no larvæ were found.

The work on the Falkenburg meadow was finished two days later and the men were taken back to the Sloope creek section, and enough work was laid out to keep both machine and hand gangs busy for four days. Close to 150,000 feet were cut on September 8th. Work enough had been laid out on the south side of Sloope creek to keep the men busy until the 12th. On that day the work that was done was inspected and found to be all right, and then more work was laid out through that section. On the 14th practically the entire hand gang was taken over to Dover township, as the work on that territory was to be finished by October 1st. This left only the machine to do work down to Cedar creek, which is the line of Berkeley and Lacy townships. Such work as could be done by the machine was done, and the short ditches were left for the men to do when the Dover township work was finished. The machine work was inspected on September 21st-22d and 27th-28th. On both of these inspections the work was found to be satisfactory and additional work was laid out.

On October 7th the men returned from the Dover township work, and the section north of the Pennsylvania railroad in Berkeley township was taken up. This area was to be left until all the other work in Berkeley township had been finished, for the reason that a rumor was afloat that the man who hires this meadow from the Pennsylvania Railroad Company would not permit the work to be done, and for that reason the work was skipped to see what the man intended to do. It turned out, however, that all the talk that was going around about this matter was false, and Mr. Butler came down on the meadow while the work was going on, and was very glad that the meadow was going to be ditched. One part of this meadow was so decayed that no ditch could be cut through to the bay, and drains had to be run from an old wide ditch to this soft place, and from there led into a large pond which empties into a creek. After this meadow was done, which took 20,000 feet, the men were taken back to Sloope creek, and the work of spurring, filling in of holes and cutting such ditches as could not be done by the machine, was finished up. I got down there on the 8th and went over the work and laid out more on the 12th and 13th to keep the men busy until the 17th.

While many obstacles were met with, high tides, the men stuck right to the work, often wading in water knee deep, and while it made it difficult to cut ditches under those circumstances, nevertheless every ditch was cut straight and deep, and just as well as if the meadow had been dry.

The biggest part of the meadow was found to be free of sand, and ditches 30 inches deep could be cut without any trouble practically over the entire meadow. The most sand was found on the Falkenburg meadow near the upland, and there sand was found from the very top, but the sand is of such a formation that the hand tools went right through and ditches were cut 26 inches deep. Mr. Falkenburg said that water could never get off that part of the meadow until late in June. Nine ditches were cut through this sandy region, and while the men were working in a foot of water the meadow drained off perfectly dry inside of 48 hours after the work was done, and the interesting part is that not only the meadow drained off dry, but three of the ditches dried down to the bottom. The reason for this good drainage is that after the top crust was cut the water quickly drained into these cuts and the sand 24 inches below is soft and porous so the water that did not drain out into the main ditch soaked into the loose sand on the bottom of the ditches. These ditches while all sandy will stand, and there was no indication of caving in after being cut three weeks. A total of 270,000 feet of ditching was done, many pools were filled with sods. This includes the cleaning of about 30,000 feet of old ditches from two to five feet in width.

The work was finished on October 24th, and was satisfactory to all the owners and, on the other hand, a perfect job was done.

Included in this territory is the stretch extending from Barnegat City Junction to the new inlet, a distance of fourteen miles. At the end of the railroad, extending south on this strip is Beach Haven, which is the most important settlement at that end of the line. To the northward no work has been done from the junction to Barnegat City.

When the work was originally done between the junction and the end of the railroad line some co-operation was obtained with the railroad, and some work was done in the cleaning of culverts and ditches that assisted in the drainage work. For a year or two conditions remained in good shape and some work was done by the railroad each spring and more work was done by the township in the way of keeping the ditches clean. South of the railroad to the new inlet the work was always in the hands of the local authorities, and this is in good condition even at the present time.

Complaint was made during the season of 1910 that the railroad was not keeping up its work, and an inspection made during the season showed that this was true. Report was made to the municipal authorities of Long Beach township and also the railroad company, but without any very satisfactory result.

An inspection was made May 12th, 1911, and conditions were found thoroughly bad. The railroad ditches were found unsatisfactory throughout, the ditches had grown up badly and a mere pretense had been made to clean up in any instance. The result of the failure was that not only was the circulation of water from side to side across the railroad dam impeded, but the circulation of the water in the small ditches to the east of the railroad was inpeded, so that very little improvement over the natural swampy condition could be found. It was noted at once that unless radical relief was given serious danger existed of heavy crops of mosquitoes from these blocked-off places.

The investigation was made at the request of Mr. R. F. Engle, and a report was made to him for the township committee. Some action was taken and a man was put on to clean the ditches in the township outside of Beach Haven. This helped matters somewhat in those cases where the ditches ran directly into the bay, but the railroad refused to co-operate, and of course the ditches east of the railroad right of way were not relieved, justifying again my decision in the areas further north not to have anything to do with the territory east of the railroad lines.

So far then as conditions extended along the whole territory between Barnegat Junction to Seaside Park while the township authorities were measurably free from the charge of negligence, the railroad authorities were absolutely negligent and are responsible for the heavy crops of mosquitoes that emerged everywhere along the route.

This seems an especially short-sighted piece of business, because of the improvements that have been made along this area north of Peahala and so-called Brant Beach. This is a new improvement, and for nearly a mile has been filled up along the railroad so as to improve breeding conditions and facilitate settlements along the railroad. With only a little assistance from the transportation company a sufficient amount of improvement could have been maintained during the season to have encouraged a much greater expenditure by permanent settlers; but so long as the railroad maintains its policy of doing nothing there will be very little encouragement for investors to put money into the area for the benefit of the line.

The railroad should particularly assist such improvements as that made at Brant Beach, because there the improvements are permanent in character and do away with the possibility of breeding, which continues where only ditching is done.

The conditions in Long Beach township, south of Beach Haven, were found good on the whole, and most of the ponds cut in 1907 are yet in good shape and stocked with killies. Only a little cleaning was needed in the long ditch, which runs from the station to the bay and which was nearly a mile in length. It was thought when this ditch was made four years ago that as it was cut through sand practically all the way it would not stand free from blockages, but it has maintained itself and has required very little attention since it was originally put into good shape. Only a little cleaning and improvement has been found necessary, and on the whole stretch of a mile in length and an area of 500 feet in width only a single breeding pool had been found during the past season.

At the request of Mr. Robert F. Engle, an inspection was made on May 12th, and again August 18th. The first inspection was made to determine what was needed to keep the breeding of mosquitoes down, and a full report was made and sent to Mr. Engle, applying in general to the township and borough. Some little work was done, but not enough, and the ditches did not get the attention that they should have gotton, therefore breeding went on.

Conditions became very bad by the first part of August, and help was again asked from the office to locate the places where the mosquitoes came from. The inspection was made on August 18th, and the southern end of the borough was first taken up to see if there were any danger points near at hand. To my greatest surprise no less than eight places were found right in the borough, sufficient not only to supply Beach Haven, but to sprinkle a part of the township as well.

The borough made a dumping ground out of a pond connected with the bay and into which tide water came fresh every day. To start with, they cut the drainage so as to leave the water in the pond stagnant, then they commenced to dump material in the water which killed all the fish, the water turned black and rotten and the mosquitoes then had free play. It can be well imagined how many *pipiens* may breed in a stagnant pool 25 x 100 feet, and they started breeding there practically as soon as the drainage from tide water was cut off, and a few loads of garbage had been dumped into the water. These little fellows were getting into the hotels and cottages in good numbers, but no attempt was made by municipal authorities to locate the danger points until the first part of August, when the pest became so thick that an appeal was sent to the office, asking that an inspector be sent down and the danger points located.

Besides this large breeding place seven smaller ones were found, three in which *pipiens* breed and four where salt marsh species were breeding. The cause for this breeding was due, in practically every case, to the blocking of the drainage. In some instances it was filling in to drive over or the laying of sewer or water pipes. By laying these pipes right across the ditches and filling or covering them over, the drainage was stopped wherever such work was done and the ditches were not regarded at all.

A full report was sent to Mr. Engle, giving the exact places where the breeding was going on, and the cause of the same.

Beach Haven, it is safe to say, bred practically all its mosquitoes right within the borough, and this could have all been prevented by a little intelligent supervision. It is just such experiences as this that has contributed largely to my decision to do as little as possible along the shore strip, except on the typical salt marsh.

Fairfield Township.

The work done during the fiscal year ending October 31st, 1910, is reported upon in my report for that year. It includes rather more than half of the marsh area within the limits of the township, and the necessary preliminary steps were taken promptly with the beginning of the new fiscal year, so that there might be no delay in starting work when the new appropriation became available. Advertisements were duly published and when bids were received it was found that Mr. Jesse P. Manahan was the lowest bidder for seven thousand dollars ($7,000), for which sum the contract was awarded to him, and all the required legal preliminaries were observed.

Work was started on November 23d with one machine and twenty men. The weather at that time was just right and the meadow was in good shape. There was no difficulty in cutting, and good straight ditches were put in rapidly, none of them less than 30 inches. The work was started between the Cohansey and Middle Marsh creeks, and along this section there is some very bad meadow from which millions of salt marsh mosquitoes hatched almost every week during favorable weather conditions in the summer.

There was no difficulty in getting outlets for our ditches. The creeks through that territory are all wide and deep and many branches run from these main creeks giving us the best possible opportunity to get off surface water. In fact, so numerous are the streams they are rather a nuisance in getting over the meadow, but it makes it possible in most instances to give our ditches two outlets. In such cases, of course, if one outlet gets blocked the other remains open and the drainage goes on just the same. At the beginning, work progressed very fast, about 10,000 feet were cut daily, and up to November 30th over 70,000 feet had been cut in good shape. At this time the gang was increased to twenty-six men.

Sufficient work was laid out for the gangs in charge to keep them busy until the early part of December, and another visit to the ground was made December 7th and 8th. The weather by that time had changed; there was a thin shell of ice and a light snow on the surface of the meadow. This, while it dulled the tools to some extent, did not prevent the men from working, as most of the ditches had been staked out before the ground was covered with the snow, and the work could be continued without interruption.

This Cohansey-Middle Marsh creeks section was finished December 10th, and on the 12th of the month the men were taken over to the Tweek and Back creek sections, which are east of where the work had been done during the summer, and this was the only piece of undrained marsh remaining in Fairfield township.

The weather now continued to be rather cold, but did not freeze the meadow at all deeply, nor hard enough to interfere with the action of the spades. The salt water coming up to the surface of the meadow occasionally would soften the icy surface and render the ice rotten and mushy, so as to prevent injury to the spades.

A thorough inspection of the work done was made on December 15th and 16th, and on the 16th additional ditches were staked out, which in turn were completed on the 22d and 23d, when the final area was staked out and finished by December 29th in good shape. In all a total of 280,000 feet of ditches was cut, and a few places that did not drain properly were filled in with sods. There are, however, very few places of that character anywhere on this meadow, which as already stated is unusually well drained naturally by the streams which give good outlets to our ditches.

The only real obstacle to the work in this area was the position taken by some of the marsh owners, who are unfamiliar with the effects of the drainage work and who were afraid of the effect of the ditching on the hay crop. They were not even open to argument in the matter and would not investigate. Had it depended upon their actions in the matter not a ditch could have been placed on the meadow. It was in most cases a brutal reliance upon the terms of the law, and a straight-forward declaration that the meadows would be drained with or without their consent, and if drained with their consent any wishes that they might have in the matter would be considered, that secured us any measure of co-operation at all. We did make some changes in the original drainage scheme to favor some of the marsh owners, but only where these changes would not interfere with the general effectiveness of the work. It is fair to say that a slow reversal of opinion is going on, and that the value of the work is becoming appreciated.

The entire meadow area in Fairfield township was inspected on April 8th and again on June 6th, and everything was found in the best condition. None of the ditches had been blocked intentionally or otherwise and the sods had not floated during the winter and spring tides, so that on the whole the drainage was clear and in good condition.

It was found that both the U. S. Drainage and Irrigation Company and Jesse P. Manahan had fulfilled that part of their contracts with the State that required an overhauling of the ditches after the winter storms and that whatever injuries might have been caused had been completely mended.

The meadow therefore during the early summer was in a decidedly good condition. Mr. Brehme reports the grass longer at the season of the year last examined than ever before at the same time, and especially so on the ten-acre meadow near Sea Breeze, which was under the water at the time the work was started, and on which no hay had been cut for eight or ten years, owing to the fact that it had been rotted out by the water lying on it continually. Since the drainage a new crop had come up, and that was already twelve inches in length at the time the inspection was made.

It had been intended to keep this meadow under a rather close supervision during the summer, and to make use of it as an object lesson. The patch of marsh land in Fairfield township is about as accessible by road and stream as any portion of the marsh land in Cumberland county, and we wished to show the effect of the drainage work on typical salt marsh in this territory and its vicinity, not only in controlling mosquito breeding but in favoring and improving the growth of meadow grasses. The burden of work imposed upon the office from various sources, and my unfortunate physical breakdown made it impossible to carry out all the plans that had been made. The meadow was not visited by me during the summer at all. It was not even possible to get Mr. Brehme down there until after the season was over, and his final report comes in under date of November and under a new fiscal year.

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